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PROCEEDINGS OF

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156th Session (1943–4) Part 2

PROCEEDINGS OF THE SPECIAL GENERAL MEETING

10 February 1944

held jointly with The Zoological Society of London.

Mr. A. D. Cotton, O.B.E., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 25 November 1943, having been circulated, were taken as read and confirmed.

The President reported the deaths of the following Fellows :—Mr. E. T. Brown, J.P., Dr. Tom Stansfield and Sir John Bretland Farmer, F.R.S.

The following were thanked for gifts made to the Library since the last meeting :—Mr. F. D. Armitage, Dr. R. E. G. Armattoe, Dr. L. H. Bailey, Mr. H. H. Bloomer, Miss M. S. Campbell, Professor G. D. Hale Carpenter, Mr. John Chear, Miss Ruth Deansely, Mr. H. E. Holtorp, Dr. C. T. Ingold, Professor J. R. Matthews, Mrs. E. W. Sexton, Mr. T. Sheppard, Professor J. McLean Thompson, Professor F. E. Weiss, The British Council; Council for Scientific and Industrial Research, Melbourne; Imperial Forestry Institute, Oxford; The Royal College of Surgeons of England.

Read for the first time a certificate of recommendation of the following candidate for Associateship :—Curtis Dudley Routh.

The Ballot for a new Member of Council was opened, and the President appointed Mr. D. J. Scourfield, Miss M. Rathbone and Lt.-Col. W. P. C. Tenison as Scrutineers, requesting them to remove the Ballot-glass after the first paper.

The following communications were read and discussed :—

Professor J. McLean Thompson. Towards a modern physiological interpretation of Flowering. (Discussed by Mr. W. C. Worsdell and Dr. M. A. H. Tincker; Prof. McLean Thompson replied.) [Printed below, p. 46.]

Dr. H. A. Baylis. Notes on the distribution of Hairworms (Nematomorpha, Gordiidae) in the British Isles. (Discussed by

Lt.-Col. W. P. C. Tenison, Mr. R. H. Burne, Mr. D. J. Scourfield and Dr. E. Hindle ; Dr. Baylis replied.) [This paper will be published in the ' Proceedings of the Zoological Society '.]

Professor F. W. Rogers Brambell. The reproduction of the Wild Rabbit. (Discussed by Dr. E. Hindle, F.R.S., and Dr. Malcolm Smith ; Professor Brambell replied.) [This paper has been published in the ' Proceedings of the Zoological Society ', cxiv. p. 1 ; 1944.]

The Scrutineers having meanwhile reported the result of the Ballot, the President announced that Professor Doris L. Mackinnon had been unanimously elected a Member of Council.

TOWARDS A MODERN PHYSIOLOGICAL INTERPRETATION OF FLOWERING.

By J. McLean Thompson,
The Hartley Laboratories, The University of Liverpool.

The present communication relates to a view-point on modern flowering which, hitherto, has received but scant attention by morphologists and anatomists.

It dwells, in the first place, on the fact that many Angiosperms bear both exogenous and endogenous inflorescences ; continuing normally in this dual behaviour throughout the major phases of their long careers. There is still much to be learned regarding such plants of diverse affinity. But even their known features suffice to show that all prior theories of phyletic transformation and re-grouping of superficial foliar or sporogenous organs are inadequate to an understanding of angiospermy.

Coupled with this, it is beyond dispute that endogenous foliar shoots are formed commonly, normally and repeatedly from the woody branches of many Angiosperms. Like the inflorescences already mentioned, these shoots need bear no relationship to originally superficial buds, long dormant and now engulfed by tissues formed through secondary changes. Both the flowering and the leafy shoots in question may spring successively and exclusively from ill-defined masses of ground-tissue within which their meristematic apices and prophylls are gradually defined and freed. As to the foliar shoots themselves, they may duly flower exogenously and later form endogenous inflorescences. Here also the known facts call for a revision of long-standing morphological doctrines.

As will later appear in an extended statement, one has come to think that the characteristic organs of any Angiosperm—be they foliar or flowering shoots or roots or members of other categories—can spring alike from living body-tissues wherever the physiological conditions which they reflect respectively are fulfilled and sustained. According to this, a root, a foliar shoot, or an inflorescence may be among the alternative products of any living tissue ; the latter being initially ' indifferent ' as to the type of plant-member which it may bear. This applies likewise

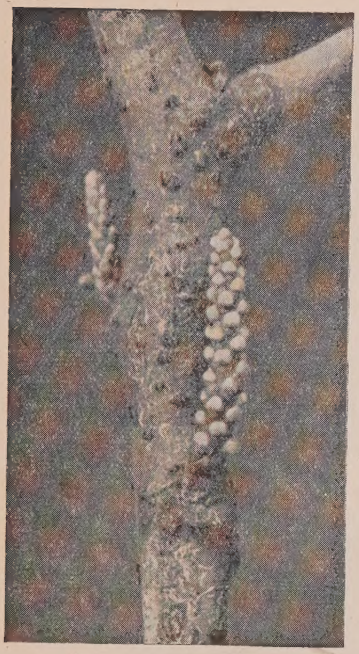


FIG. 1.

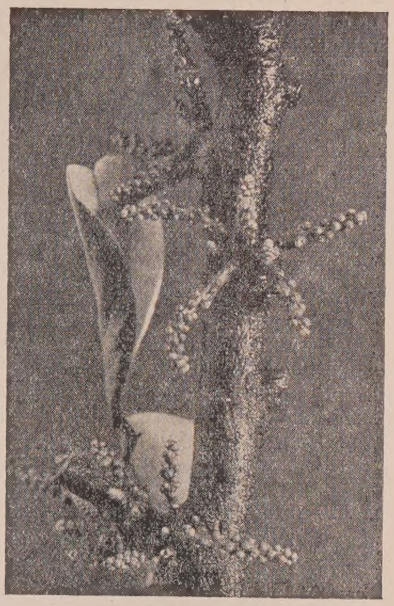


FIG. 3.

FIG. 2.

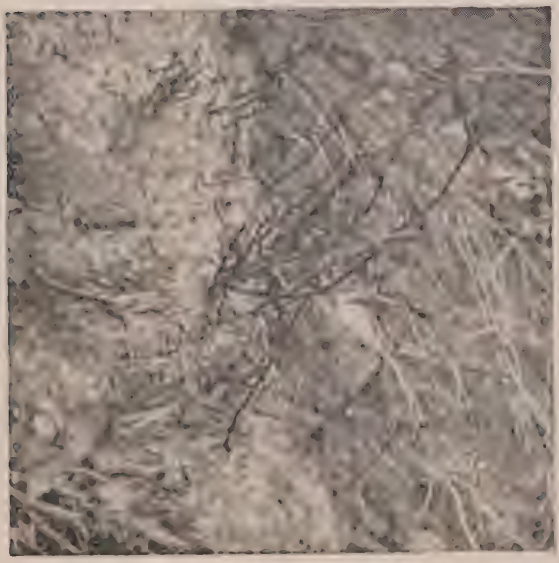
to any protruded primordium, so that, for example, a bracteole or a sepal, a petal, a stamen or a carpel may be potential in each and every protuberance from a growing floral receptacle. Likewise the view is taken that definite morphogenetic factors will duly be revealed—each, as it were, a stage in the alteration of a basic state of tissue and capable of affecting the course of development, the morphology, the structure and functions of primordia or of tissue-masses within which it is displayed.

The writer's interest in this matter of organ-determination was first quickened through the study of tropical cauliflorous plants. In some species, endogenous foliar and flowering shoots are formed in basipetal progression and in increasing profusion, even the cortical tissues of their trunks and major limbs becoming the sites for shoot-protrusion. Exogenous foliation and flowering may meantime proceed without abatement upon their delicate and distal branches. There are other species whose cauliflory need not regularly involve endogeny but which may relate, as in *Forsythia*, to a partial commitment to flowering of multiple superficial buds upon matured or maturing long shoots. In such plants, a subsequent and extensive formation of new foliar shoots may be referable mainly to the residual buds on which the acts of flowering have not been imposed. There may also be extensive endogeny. Here also it is worthy of note that some of the buds mentioned above may develop directly as normal and functional 'roots' from which, in due course, foliar shoots may arise. As enquiry into such matters has proceeded, it has become evident that the developmental and morphological events must be outlined apart for a number of independent species, their implication being faced by progressive steps. It is to this end that the salient features of the Carob Tree (*Ceratonia siliqua* Linn.) are now briefly recounted.

The initial flowering of this plant is by terminal spikes whose developmental predecessors are foliar buds. Each lateral leaf beneath this inflorescence has a single bud in its axil. Each axillary bud is initially in the vegetative state.

Once terminal flowering has occurred and the subjacent internodes have been lengthened and their secondary growth-changes have begun, the single axillary buds may pass gradually into the state of inflorescence. The progress of this new flowering is commonly basipetal, although individual buds may remain dormant in the leaf-axils or immediately above leaf-scars (fig. 1). As a season advances, there is a general lowering of the level beneath which purely vegetative buds may still be observed. Before the season has closed, this lateral exogenous flowering is commonly completed over the entire length of each increment to the branch-system.

Unless fertile pods are formed upon it, each terminal or lateral pedicel is duly shed, save for a cork-sealed stump which may still bear a varied array of superficial buds. Before a further season of growth has advanced, these stumps may be entirely cork-clad, as are the adjacent nodes and internodes. The isolation of the superficial buds from the living cortical tissues of the stumps is generally soon complete. It is within these cortical tissues that the first endogenous inflorescences arise. Their initial number is generally small : their positions and arrangements are irregular. In due course there is definite elongation of each internodal



(*upper*) FIG. 4. (*lower*) FIG. 5.

base, whereby each stump is separated from its subjacent leaf-scar. There follows a rupture of the cork-covering of each stump and the protrusion of the new inflorescences (fig. 2).

Only a brief sketch of the later progress of this endogenous flowering

can be offered here. As the branches age and secondary growth progresses, the original stumps are enlarged on ever-widening bases. They gradually assume the form of irregular mounds within the cortical tissues of which still more numerous endogenous inflorescences are engendered (fig. 3). In later stages of development these mounds commonly become warty wens from which numerous endogenous inflorescences protrude in chaotic manner during any flowering season (fig. 4). Such flowering wens often cover much of the surface of sturdy branches and may be well developed and fully fertile on the trunks themselves.

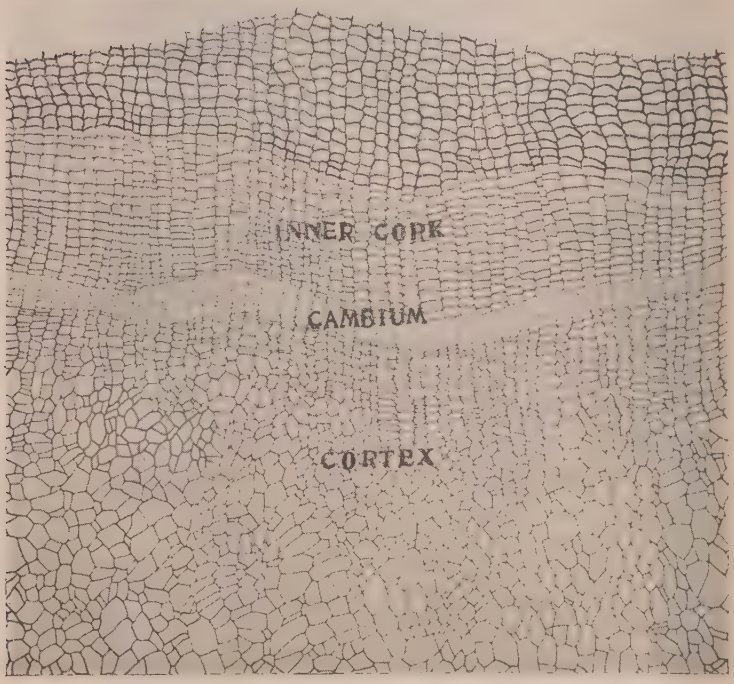
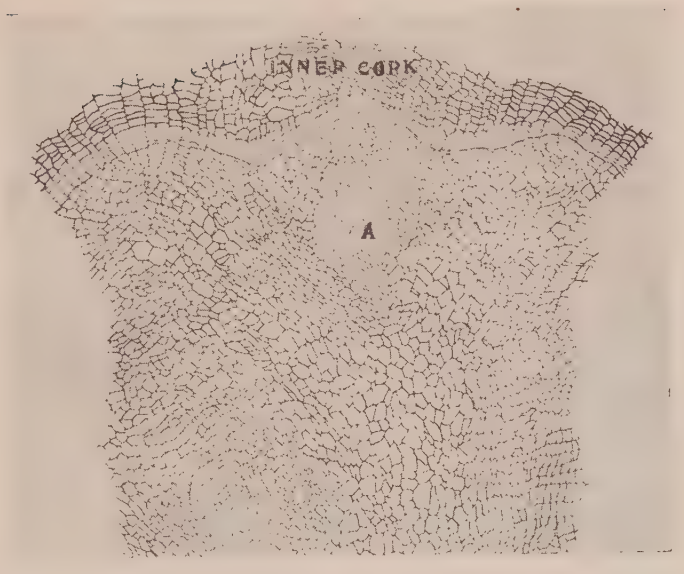


Fig. 6.

Here also it must suffice to state that there is initially a close developmental and structural parallelism between the endogenous inflorescences of the Carob and the endogenous foliar shoots which spring in greatest profusion from its sturdy bole. A fair notion of the general course of inflorescence-formation may therefore be gained from even a brief survey of events within the cortical tissues of the bole.

Once endogenous foliar shoot-formation has become a general feature of a sturdy branch or trunk, the surface of this organ is raised as encircling bosses from which the majority of the shoots are freely, directly and erratically protruded through the cork, either singly or in close clusters (fig. 5). The shoot-initials are nothing more than ill-defined masses of



(*upper*) FIG. 7. (*lower*) FIG. 8.

parenchymatous cortex such as might be selected in any position beneath the cork-cambium in fig. 6. Once an initial mass has become actively meristematic, its sectional appearance may be as shown at A, fig. 7. Its histological continuity with the cortical massive is maintained on all sides until, as in fig. 8, an apex, A, and prophylls, B B, are freely defined within a cortical chamber. It is through the rupture and destruction of external cortex and cork that the protrusion of such a shoot is prepared. As in fig. 9, there may be simple prophylls, A A : their immediate successors, B B, may duly develop as pinnate leaves.

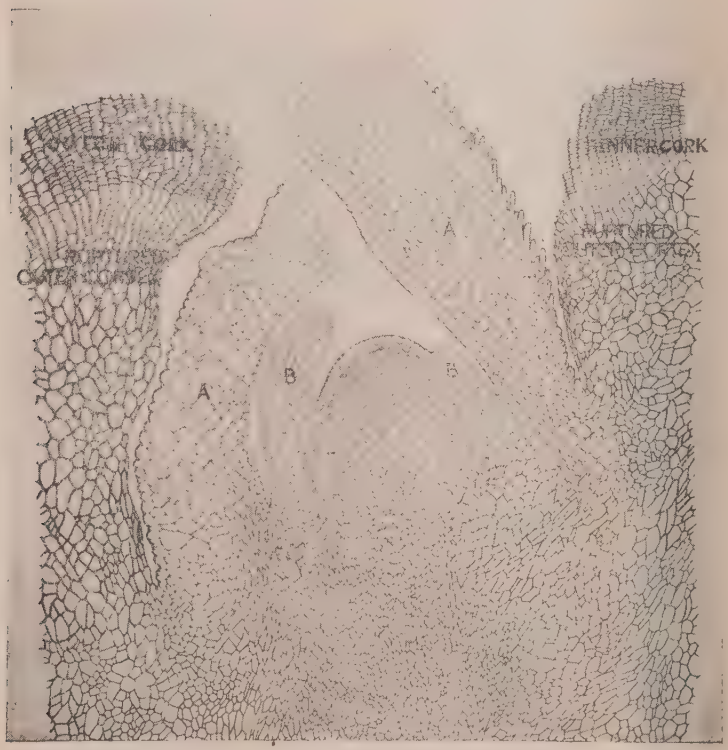


Fig. 9.

Since it is among the purposes of this article to establish endogenous foliar and flowering shoot-formation as a normal fact rather than to enter into its many known variations, one must be content to state that foliar and flowering shoots may be closely intermingled within the tissues of the Carob bosses, so that there can be no easy prediction as to which will emerge in any given position or as to what will be the proportions of foliar and flowering shoots on any boss in a given season. Even

were there no further evidence to consider on this matter, the implication would be strong that foliar and flowering shoots are alternative products.

And, as in this plant, so also it has been noted in others that the majority of the initial cortical buds originate radially opposite medullary rays, that vascular connections are soon established between them and the bast and wood of the parent organ, and that once a bud has been established with such relationships, many others may arise around it and form vascular connections directly with it rather than with the conductive tissues of the parent trunk or limb. The matter is likewise with the endogenous inflorescences formed within the more distal wens.

It is also worthy of brief note that, as in the Carob, so also in other plants showing endogeny, there may be a prelude to the latter in that generalized cell-division rather than strictly localized meristematic activity may occur in any position throughout a small though appreciable cortical mass of the trunk or limb ; this being accompanied by progressive activation of the cork-cambium covering the mass involved. The immediate result is the gradual elevation of adventitious and cork-clad

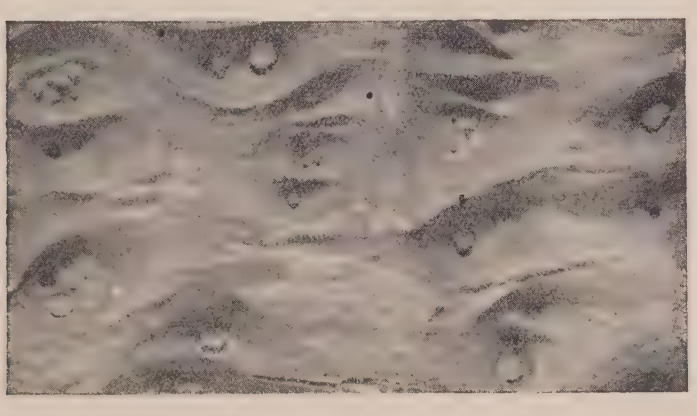


Fig. 10.

pegs, within the parenchymatous cores of which endogenous buds are formed successively or in groups in subterminal or lateral positions. These buds have, of course, no subtending organs. But when, as is common, the subterminal bud has been protruded so as to form a prominent shoot, and those subjacent to it are finally exposed, one has the impression of a true short shoot whose apex has no longer been retarded. In contrast, there are other cauliflorous plants, such as *Pleiocarpa* and *Abeliophyllum*, whose true short shoots become cork-clad save for their very summits. Their retarded apical buds may duly expand as long inflorescences, and foliation—through endogeny—may later ensue within the basal peg. This reference must serve merely to illustrate that endogeny is not pursued by flowering plants on a single plan.

The attention of physiologists is drawn especially to such plants as the Carob as presenting well some definite field of enquiry. Thus, for example, the cortical tissues of the flowering wens and of the trunk-borne bosses are easily dissected, so that the pearly mother-masses of all buds are readily recognized and may be removed intact within a few layers of cortical tissue. In the case of a massive trunk one may easily isolate a considerable mass of meristem, sufficient perhaps for microchemical examination by modern methods. A parallel isolation of the investing cortical tissue and its similar examination may serve to suggest some factors in meristem-definition. Also, in the case in hand, the freeing of the bud-apex with its prophylls has so far been noted only on the external margins of the meristematic masses, the vascular connections of these first initials soon having each an anchoring tissue-dome athwart the cambium and expanded within the extremity of a medullary ray. It may not be beyond biochemical devices to throw light on some facet of polarity through the comparative study of these deep-seated meristems and of the tissues radial to them, both within and without. Further, it is a simple matter to decorticate large areas of bosses from sturdy trunks, long incisions having been made to the depth of the cambium, and gentle leverage having been applied along the planes of incision. The inner surface of each freed boss is ruptured cambium. The anchoring domes of the endogenous buds may have suffered no more damage in the process than the severing of their connections with the subjacent wood and bast and with the flange-like rays. They thus project singly or in groups from the irregular inner surfaces of the bosses, as is shown for a small area of one of the latter in fig. 10. There are parallels to this in such common plants as the Elm and the Sycamore, regarding which it has commonly been assumed that their epicormic shoots arise exclusively from dormant buds which previously have been engulfed within a thickened axis. Is there not then here a ready field of study in which bud-bearing decortications, the endogenous buds in course of development, and the anchored shoots which they form may be used experimentally in matters of grafting, root formation and tissue-culture ?

As the study of cauliflorous plants has advanced, and it has become increasingly evident that *either* a foliar *or* a flowering shoot may be developed from an exogenous or an endogenous meristem and that reversion of state is oft-recurrent, questions have grown more insistently as to what may be the factors which determine this or that course of development within a shoot, as to which are major factors, and as to where they reside. The time has not yet come when final and well-balanced answers can be given. On the other hand, it is within our power to furnish a true account of the morphology and detailed histology of any known meristem, to determine the stages in development of its products at which organs of each definite category are revealed, to note the state of the meristem at successive phases, to correlate such states with the positions, numbers, statures and structures of the organs engendered, and to trace the visible events of changing form and organization which characterize the development of each organ-type.

All this is needful as a solid background by which, in due course, physiologists may better judge their own observations. So far as the Carob and other such plants are concerned, this latter objective has so far been approached more fully through the study of forming foliar and flowering shoots which have been recognized as such than through the analysis of initial meristematic masses still in an indefinite state. Here only a few points from the field of study can be selected for special reference. Thus it is convenient, in the second place, now to consider briefly some established features of Carob flowering, with special reference to meristic variations and their dependent implications.

The chosen starting-point for the study of meristic variations in the Carob has been the repeated examination of apical buds, of lateral bud-initials, of endogenous buds with their apices and prophylls just defined and freed, and of the products of all such buds during their early stages of development. Apart from the matter of distinctive prophylls, already mentioned, no obvious morphological or gross structural differences have been noted by which prediction might be made as to the final form or state of any shoot. Without exception, all the developing shoots or buds maintain, at first, a domed apical meristem beneath which ' foliar ' organs arise in unbroken spiral succession. The distal domed meristem may be long retained as a definite dome. Single buds, initially similar to these just mentioned, are duly initiated in acropetal succession in the axils of most of the ' foliar ' organs. The absence of such buds relates only to the closely crowded and very young upper ' leaves ', in the axils of some of which they may, in time, be formed.

It would thus appear that if the meristematic dome of any such shoot is maintained throughout development ; if the ' foliar ' organs gradually attain the form, structure and state of bracts ; and if each subtended bud becomes a flower, the consequent inflorescence is potentially a simple indefinite spike. On one of the alternatives of development each subtended bud may give rise to a similar lateral spike : on another, each lateral bud may be the point of origin of a minor spike of spikes. Such simple spikes, and others of higher order of branching, are common in the Carob. The study of their development leaves little room for doubt but that the form and organization of these inflorescences are direct reflections of the retention of some domed apices more or less in the ' initial ' state of growth and the commitment of others to the distinctive flowering state. As the alternative to each axillary flower may be a branched or unbranched spike, so the extreme alternative to any indefinite inflorescence may be a single definite flower ; all this depending on the stage in development at which the flowering state is approached and attained in any apex. Here there seems to be no true question of flowers as fixed morphological entities, but rather of meristic variation in its broadest sense.

The Carob has many forms of inflorescence, both racemose and cymose, and also many floral types, apart from those which have served the immediate purposes of systematists. Only a few elements from the study of these forms and types can now be considered by reference to fig. 11, which shows, as in projection, a common form of *definite*

inflorescence, crowned by a single flower, 13. The figure is, of course, composed from many inflorescences, so that common types of subtended flowers or lateral branches of the inflorescences are represented. Accepted bracts are B^1–B^{12} : the single flowers or branches of the inflorescence which they subtend bear the large numbers 1–12. The successors to the unbroken series of bracts, B^1–B^{12}, are P^1–P^5, which are the sepals of the terminal flower. B^{10} subtends an indeterminate apex. Only B^1 and B^{12} subtend single flowers ; the remaining bracts subtend flowering

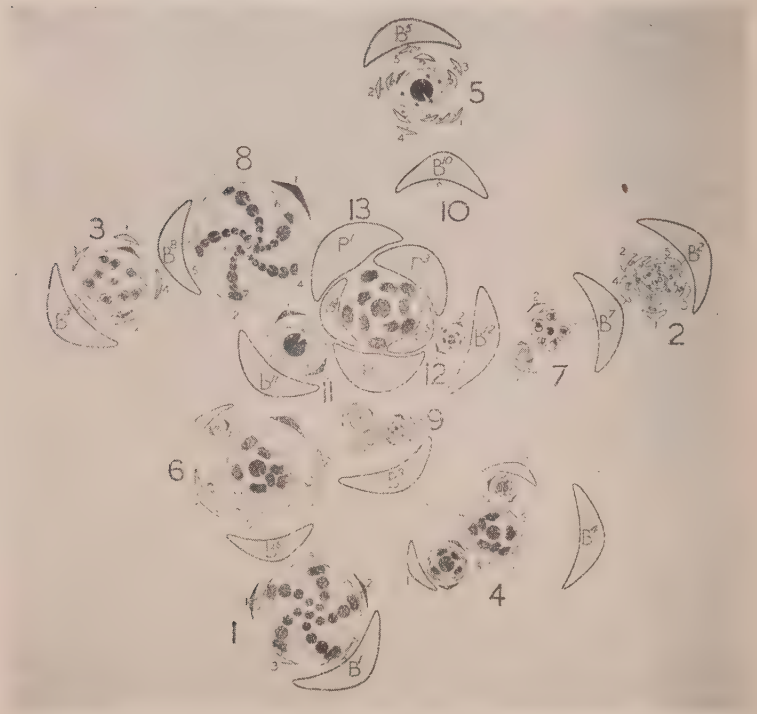


Fig. 11.

branches of varied order. B^2 subtends an indefinite flowering branch with its small bracts in spiral succession, the first being numbered 1–5 ; each bract subtends a single flower. B^9 also subtends an indefinite inflorescence with three bracts, each with a single axillary flower. B^5 subtends a definite inflorescence with flower-subtending bracts such as are numbered 1–5. The terminal flower of this branch has a single bracteole shown in solid black ; this bracteole is a member of the spiral succession including the bracts, and which is continued unbroken by

the sepals shown above upon the floral disk. B^4 subtends a definite inflorescence with two bracts, each with an axillary flower possessing two bracteoles and five sepals. The terminal flower of this lateral branch has no bracteoles; its five sepals are numbered 3–7. Together with the lower bracts, 1 and 2, the sepals form an unbroken spiral succession of organs. B^3 subtends an inflorescence with terminal flower alone maturing. This flower has two bracteoles, one of which has an arrested axillary flower, and may, more properly, be called a bract. Functionally, the rachis of this lateral inflorescence is the pedicel of its terminal flower; it carries basally five apex-subtending bracts. These bracts, the bracteoles, and the five sepals on the disk of the terminal flower form an unbroken spiral succession. B^6 subtends a definite inflorescence with three bracts, each with a small axillary flower. The fourth organ in the spiral succession is shown as the sole bracteole of the terminal flower, although it has an axillary apex. It is followed immediately by organ 5, which is the first of the five sepals on the disk of the terminal flower. B^7 subtends a two-flowered inflorescence. There is only one bract, the smaller flower being in its axil. The terminal flower of this lateral branch has one bracteole without axillary apex: the equivalents to this bracteole in branches 9, 6, 5, 4, 3 and 2 are bracts. B^{11} subtends a single flower, there being an axillary apex to the upper of its two bracteoles. At least a two-flowered branch might therefore have been formed. B^{12} subtends a single flower bearing the bracteoles and sepals of the systematic descriptions. The interpretation of this as a unit flower clearly depends entirely on the absence of apices or flowers in the axils of the bracteoles. As to the flower in the axil of B^1, it has two bracteoles, 1 and 2; five sepals, 3–7; five stamens and sixteen legumes, all these organs being in unbroken spiral succession, of which the eighth to the twelfth are stamens and the thirteenth is the first or lowest legume. The flower axillary to B^8 has one bracteole and five sepals, 2–6. The latter lead in unbroken upward succession to twenty-four legumes which are followed by three stamens beneath what is known to be the domed apex of the receptacle. In this case, organs 7–11 are the lower stamens and organ 12 is the first legume. The terminal flower of the lateral branch 6 has six sepals, the lowest of which is numbered 5. There are seven stamens and a single terminal legume. Thus the tenth organ in the succession is the uppermost sepal; the eighth is the lowest stamen. As to lateral flower 3, it may readily be confirmed that its five sepals are organs 8–12 in a spiral succession, the immediate successors, 13–20, being eight stamens. It will be recalled that in the lateral branches 1 and 8 mentioned above, organs 13–20 are legumes. As to the terminal flower of the inflorescence as a whole, 13, it has five sepals, P^1–P^5, and a terminal legume.

When this matter of meristic variation is brought to an ultimate analysis for a species which, like the Carob, shows floral organ-initiation in unbroken spiral succession, the only practical hypothesis offered seems to be that such organs as bracts and bracteoles, sepals, stamens and legumes, or other organs characteristic of the inflorescences of a species, are alternative products of 'indifferent' primordia within each of which some definite morphogenetic factors or states come to dominance.

This is in direct opposition to an older emphasis on a rightful quest for some one fundamental or prototypic organ in flowering ; and which, in passing, no one has truly ventured to identify, since it, in turn, would claim interpretation in terms of others more remote. It is, indeed, a basic point in the writer's beliefs that the initial 'indifference' of primordial or other meristematic tissue must be acceptable for all phyla if progress is to be untrammelled in the study of causal morphology. And if, as on this view, it be near the truth that the factors or states determining the morphology, structure and condition of each type of floral organ come to be located mainly and effectively within the successive apical domes of a growing receptacle and the successive primordial groups thereon, should it not be chiefly upon progressive modifications of state within the apices and their immediate emergences that physiological enquiry may most hopefully, though laboriously, be pursued ?

Among the features of Carob flowering which are closely bound with meristic variations are such phenomena as brachystemony, obdiplostemony, and the contrasting floral types which we commonly describe as male, female and hermaphrodite. One cannot enter here in detail into any of these matters, but must be content to refer, in the third place, only to some common types of flower which are at first surprising, and even disconcerting, and which can throw a valued light on the events of flowering as a whole. It is perhaps true to state that we have grown so accustomed to such ascending sequences of floral organs as perianth, androecium and, finally, gynaeceum that we may accept them, without special enquiry, as if they were inevitable ; having no rational suggestion to offer as to why androecium is not dominantly distal, as to why mixed successions are rare, or as to why gynaeceum-formation with ovulation and fruiting so dominantly closes receptacular development. We are often prone to visualize 'central' hermaphrodite floral types, from which we arrive mentally at polymorphism only by figuring the complete suppression of this or that group of 'essential organs'. Commonly we allow of interplay between perianth and androecium on the conception of meristic variation, while insisting that androecium and gynaeceum are strictly apart. The writer believes that there is a rational explanation of the dominant ascending progression from perianth to androecium and thence to gynaeceum in that it is the direct reflection of *gradual* ontogenetic changes in the state of apical meristem and in such meristematic tissue as the latter contributes to primordia. According to this view, the dominant drift of these physiological changes is in one direction, namely, towards the long retention of the products of meristem *as such*, as in androecium, to a still greater and progressive manifestation of this phenomenon in gynaeceum-formation, and to the final attainment of its present maximum in ovulation. The prelude to this is, of course, the inception of flowering which seems to involve at least a redistribution of apical meristem in any shoot which otherwise might have continued in the purely somatic state, with foliation alone as its most evident expression. Further reference to this progression of physiological changes and to their consequences is made in later paragraphs.

The floral types mentioned above can best be understood against

the following background. Hermaphrodite flowers with five or more stamens and with single terminal legumes, male flowers with inconstant androecial number and with single rudimentary terminal legumes, and female flowers—both with and without staminodes,—and with single terminal legumes,—predominate in Carob flowering. The truly terminal legume involves the apex of the receptacle as a whole in all such flowers in which there may or may not be bracteoles, the sepal-number is variable, the stamens may be entirely long or wholly or partly short, and the orientation of the terminal legume is inconstant. But no matter what may be the part-number in any hermaphrodite or male flower, the spiral successor to the uppermost bracteole is the lowest sepal and the spiral successor to the uppermost sepal is the lowest stamen. Whatever may be the condition of any organ in any such flower, there are no gaps in the spiral lateral succession, nor, while the flower is still young, are there special space-intervals between the primordia or between any two categories of forming organs. The matter is likewise with regard to bracteoles, sepals and staminodes in the young female flowers ; it being understood that when there are no staminodes, the uppermost sepal is immediately beneath the forming legume.

Only floral types whose development is fully known will be mentioned in contrast. Commonly two, three or more lateral legumes are formed in the hermaphrodite flower, these legumes completing the undisturbed spiral succession of bracteoles, sepals and stamens. There may be a truly terminal legume to such a flower : alternatively, the apex of the receptacle may remain ' uncommitted ' as a small meristematic dome. Whatever may be their number, the lateral legumes show constant orientation. On the other hand, there are common hermaphrodite flowers in which the forming bracteoles, sepals and stamens constitute, for some time, a close spiral sequence crowned by a small domed apex. In due course, the latter grows actively, so as to form a lengthening cone with broadening base and many lateral primordia continuing the orderly lateral organ-succession below. Most commonly, these upper primordia develop as legumes, and the apex of the cone is likewise committed to the formation of a terminal legume. There follows a gradual and considerable elongation of the base of the cone in such flowers, thus furnishing a prominent gynophore with distally crowded legumes. The parallel result for a maturing female flower is shown in fig. 12. Still further, in both hermaphrodite and female flowers—either with or without an obvious gynophore—the apex of the receptacle may become the point of origin of a foliar bud. The lower right-hand terminal flower in fig. 13 gives a fair illustration of a female flower with multiple legumes and whose apical region is commonly a leafy bud. Such buds may enlarge as functional foliar shoots : alternatively, any one of them may become a flower or an inflorescence.

The point in hand is still more closely approached if one considers the common form of Carob flower which is viewed obliquely from above in fig. 14. Its pedicel bears a single unexpanded flower : there are fertile and sterile stamens on the margin of its disk. The sturdy central column rising from the disk cannot be seen ; but its mid-region carries a close spiral succession of lateral legumes which are followed immediately

upwards by eight short lateral stamens, the anthers of two of which have been removed so as to expose their stumpy filaments. The column ends in a single terminal legume. This column can no longer be called exclusively a gynophore ; nor is the name ' floral receptacle ' sufficiently

Fig. 12.

Fig. 13.

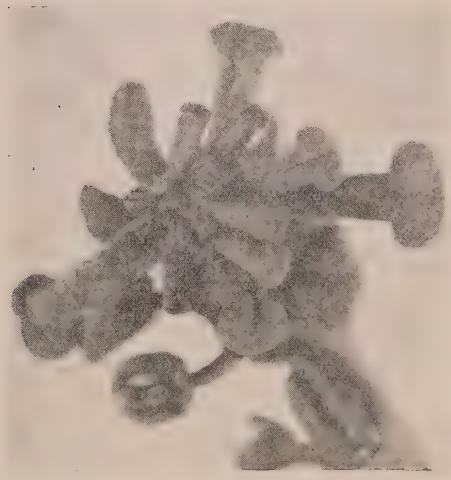


Fig. 14.

comprehensive to cover even the range and spiral successions of organs which have now been selected for mention.

Such oft-recurrent variations lead anyone constantly engaged in developmental study to advance and seek to test the following hypothesis. Since flowering may take its inception on any shoot and at

many seasons ; since the dominant ontogenetic sequence of events may be the formation of bracteoles and sepals, petals, stamens and carpels—or their correlatives—and finally ovules and maturing fruits which close the careers of the shoots involved ; since meristic variation is common when the floral part-numbers are high and organs of transitional category may then arise ; and since one may so often identify the tiny organs of any category which closely beset the floral apex at successive developmental stages, there is potential in the advancing apex and its immediate emergences a gradual change of physiological state, each step of which has its own morphological and structural expressions, and whose dominant present climax involves the final apical products in ovulation and fruiting. According to this, there may be no bracteoles when, through the rapid completion of a step in physiological change and like entry upon its most natural successor, sepals arise from the first-formed primordia. There may or may not be petals, but stamens may follow most commonly when a further step in this physiological change is likewise rapid. These stamens will reflect in their number and distribution the ontogenetic period during which no further alteration of apical state has been effected. The consequent flower will be truly male if the penultimate and ultimate steps in physiological change do not ensue : it will be truly female if the latter are in full progress after the phase of sepal- or petal-determination has been passed. According to this also there may be an ontogenetic reversal of the physiological state of the floral apex and its emergences. Thus as Carob stamens may be followed directly by legumes, so the latter may be followed by stamens, as shown in fig. 14. This matter need be carried no further than to refer once more to the arbitrary barrier which has been imposed so insistently between androecial and gynaecial organs, as if they were things which must be kept strictly apart in time and place. For it is not uncommon in Carob flowering to find the repetition of stamens and legumes intermingled in series within an unbroken spiral succession, to be followed ultimately by sepal-formation and the definition of a distal flower, by a terminal inflorescence, or by a final foliar bud. Lastly, on this matter, one has to date no further inkling as to the nature of the progressive physiological change envisaged than that it seems to be accompanied by an increasing retention of proteins in the organs successively engendered within the sequence bracteoles to ovules, as is also the case in the actual apices beneath which organogenesis is in progress. There is, however, here a field of exact study immediately open to morphologists and anatomists, and which properly constitutes the fourth point in the present statement.

Time and again one has vainly sought to discover definite morphological and histological differences between successive series of lateral primordia on the forming receptacles of Carob flowers, and by which the nature of subsequent organs might possibly be predicted. All are initially and entirely meristematic domes. Close comparative study has shown, however, that in organs later characterized as bracteoles and sepals there is an early and rapid advance of cell-enlargement, dominantly so all-embracing that there is soon no residue of small meristematic cells even at the base of the adaxial face of the forming organ.

Rapid cell-enlargement and tissue-maturation dominate the first or lower primordia. More small-celled meristematic tissue is generally formed before cell-enlargement becomes progressively evident in the organs commonly matured as sepals. It is on the retention of small epidermal and hypodermal meristematic groups at the adaxial bases of both these types of organ that later bud-formation seems to depend, and whereby one renames them subtending bracts.

It may be noted in passing that, as in the Carob, so also in many other plants examined, the attainment of foliar form by bracts, bracteoles and perianth-segments involves also considerable epidermal and hypodermal cell-enlargement within their respective and concurrent zones of receptacle. The gross result is an excess of tangential expansion over radial or longitudinal expansion of insertion-area.

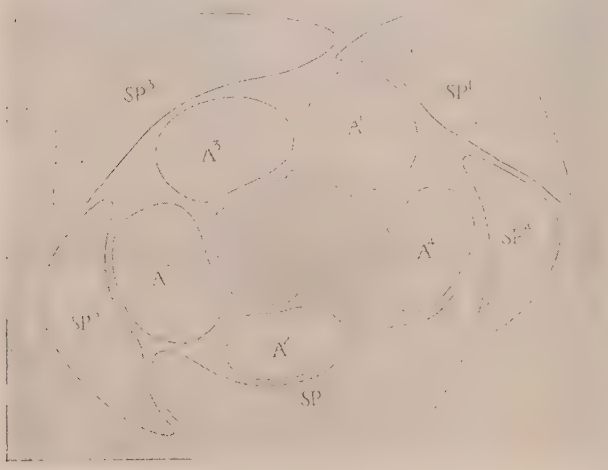


Fig. 15.

As to forming Carob stamens, there are composite features whereby prediction of their inception may be attempted. Their first indication seems to be that the primordia involved continue to be almost cylindrical and, for a long period, to retain small-celled meristem. Further, there is no early and pronounced cell-enlargement beneath their insertions. Subsequently, there is no dominant tangential expansion over radial longitudinal expansion in either their insertion-areas or their bases. In addition, the gradual grooving of the stamen-head—and which leads to the definition of anther-lobes—results from the long retention of the original small-celled and active meristematic state along progressively narrowing lines, and from the gradual abandonment of this state in the epidermis and hypodermis of the future lobes. Wherever the meristematic

state is localized and sustained, there is a superficial ' depression ', much as is common at the growing points of a *Fucus* or a *Marchantia* or in the formation of conceptacles in many Brown Algae. Further, as procambial tissue is gradually indicated throughout the core of the forming stamen, and as the ungrooved filament is defined, cell-enlargement progresses outwards through the future connective ; large-celled connective-tissue being duly linked locally with comparable tissue of the future anther-wall. But throughout all these changes in form and state there is retained persistently a group of deep-seated and diminishing masses of original small-celled meristem which comes to constitute the functional archesporium in all modern stamens so far examined. The general implication is that the ontogenetic passage from perianth to androecium occurs whenever and wherever the change of physiological state is such that cell-enlargement and rapid maturation are no longer paramount and all-embracing in a forming organ. According to this, one should not think of the archesporium of a stamen as gradually furnished. Its original limits could continue even to the hypodermis. The mature organ could be a monosporangium just as readily as it is synangiate in species of *Rhizophora*. And, as in the latter, so also in other alliances, it is now well known that anther-form and final state reflect directly the ' selection ' and the number and positions of epidermal and hypodermal bands which early remain meristematic, rather than on the form, mass and distribution of the residual groups of deep-seated meristem.

It is a central point in the present approach to flowering that as bracteoles or sepals, or petals or stamens, are alternative products of initially ' indifferent ' primordia, so also it should prove that stamens and carpels are also alternatives according to the events within primordial products. It is therefore of interest to note that while the dominant product of the apex of the Carob receptacle is a terminal legume, it is also commonly a terminal stamen which may be the sole organ above the sepals (fig. 13). One may also suggest that as the instruments of physiological enquiry are refined, it may prove that what, for lack of a common term, may here be called the imprisonment of original and enduring meristem within maturing tissue brings in its train the conditions of segregation, the causes of reduction-division, and the events of sporulation. Here it is implicit that segregation, reduction-division and sporulation need not occur even in an organ which has entered upon the path towards stamen-formation, provided its enduring meristem remains as ' free ' as is the superficial apical and meristematic mantle of the parent receptacle. Coupled with this is the demonstrable fact that, whenever cell-enlargement duly becomes operative throughout the potential archesporium of an anther, there is neither segregation nor reduction-division nor sporulation in the latter. Here at least is a field for experimentalists in which the so-called ' lower plants ' may also be widely used.

As to forming Carob legumes, it has been of some advantage to be able to observe them in both lateral and terminal positions. Whether lateral or distal, the future legume at first resembles the forming stamen in all respects. There is no dominant cell-enlargement beneath it :

its base remains cylindrical. There is no question of the assumption of foliar form by marginal infolding ; but some one face is generally ' selected ' for the retention of small-celled and active epidermal and hypodermal meristem as shown in mid-transverse section of a young terminal legume in fig. 15. The future ovary depends entirely on the length and depth of the consequent groove beneath which both hypodermal and subjacent original small-celled meristem persists in active division. It is on the faces opposed and lateral to the one which is grooved that cell-division gradually subsides and cell-enlargement progresses ; thence advancing inwards to an appreciable depth. But in contrast to stamen-formation, this advance of cell-enlargement does not extend athwart the organ to the hypodermis and skin of the groove. The latter remains lined throughout by a considerable unbroken expanse of epidermal, hypodermal and deep-seated original meristem from which alone ovules may subsequently emerge. The condition, already

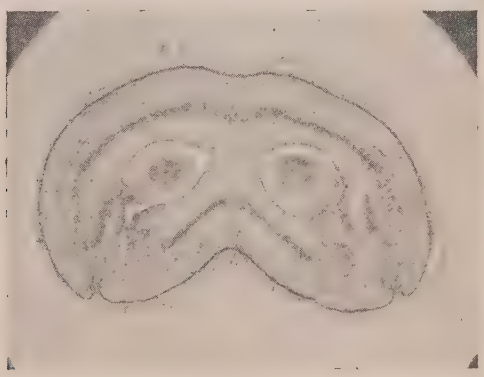


Fig. 16.

mentioned, of enduring meristem remaining as ' free ' as in the superficial mantle of the parent receptacle is fulfilled. This display of considerable and uninterrupted meristem is characteristic of every type of forming gynaeceum so far examined. According to the species concerned, so may be the gynaecial ' model '. According to the number and arrangement of the meristematic grooves which are maintained throughout development, so the number and arrangement of potential ovaries and placenta are determined either for unit lateral carpels or for a terminal unit gynaeceum formed from the apex of the receptacle itself. It may be remarked that there is no question of segregation, reduction-division and sporulation affecting this continuous ' free ' meristem. These phenomena do not present themselves once more until further emergences —now known as ovules—have been formed and original meristem is subsequently imprisoned in their nucelli.

Attention should also be drawn to two common and interesting facts shown by the Carob. The first is that the variable orientation of the

single terminal legume depends entirely on the face of the young organ upon which the display of active meristem is maintained. Thus the single ovarial chamber may be defined on either of the anterior faces or on either of the lateral faces of the legume shown in fig. 15. So far, no exception has been noted to the uniform choice of the adaxial face in the case of lateral legumes. The second fact is that unit terminal legumes with multiple ovaries are common. Thus, as is shown in fig. 16, two lateral faces may be involved. Alternatively, the unit legume may be locally unilocular and locally bilocular, according as there is a developmental 'branching' of the path along which meristem is retained. Quite commonly, there are parallel and independent ovaries on three adjacent faces, as in fig. 17. The employment of all five available faces shown in fig. 18 has not yet been observed. These illustrations may, however, serve to show how plastic are the affairs of morphology and how needful is a knowledge of the nature and location of causal factors.

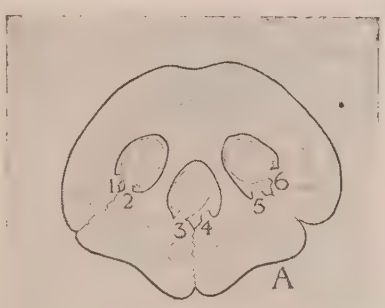


FIG. 17.

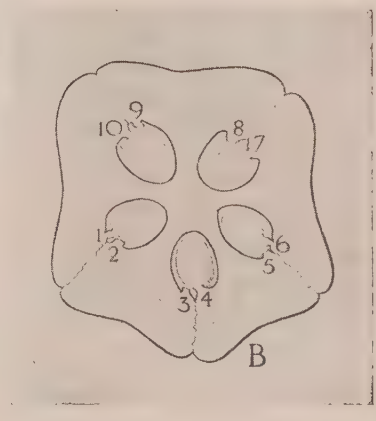


FIG. 18.

A simple line of thought may merit attention. If the initial meristem of a forming legume or other gynaecial organ persisted in uniform activity upon and beneath its surface, there would be no ovaries in a plant which is truly an angiosperm. There would be gymnospermy in the widest sense if functional ovules duly emerged from the cylindrical or cavernous gynaeceum. May one not, therefore, rightly speculate more or less as follows? The main drift of physiological change in modern flowering is from the effacement of meristem, as in perianth, to its partial and deep-seated retention, as in androecium, and thence to its more extensive and 'free' survival, as in gynaeceum, beyond which and ovulation there is another attainable climax, namely, the complete retention of meristem and its products in the state of youthful tissue.

As to the events of ovulation in the Carob, one must be content to mention briefly that it is within its nucelli that the closest approach

is made to the ideal climax suggested immediately above. The parallel to this has been noted in many other species. One's general impression of the events of ovulation can be expressed more or less figuratively as follows. It is as if all but a tiny fragment of a nucellus persists as initial small-celled meristem, remaining free from transformation such as is due to the factors which make for cell-enlargement. The events of its extensive destruction overtake it in this unaltered state. Also it may be noted that even a single functional archesporial cell within a nucellus is at least hypodermal and, indeed, no archesporium may be defined. A theoretical point affecting at least a common conception of Hofmeister's grand hypothesis is that neither the archisporial cell of a nucellus nor its tetrad-products may differ staturally from the corresponding cells in an anther. This has been put to the test of exact measurement in many plants. Its immediate significance seems to be that although heterospory in the functional sense is a reality in angiospermy, it is not necessarily synonymous with microspory and megaspory in, for example, some Lycopods, as has often been implied. To face this fact is to call for further evidence on the possible or phyletic retention of a megaspore within the parent sporophyte.

It has been necessary to seek a general background for the changing states of floral organs through the progressive study of shoot-apices from which both they and foliar organs arise. As to the Carob, this has led to a comprehensive survey of the embryo and seedling, and of young and well-established plants. Only elements from this study are now mentioned. The first is that, throughout the phases of foliation, the young lateral primordia closely beset the shoot-summit and have, as it were, transferred to themselves a considerable portion of small-celled meristem which might otherwise be displayed within an extensive apical meristem. The second is that these primordia have an early ascendency in growth-rate, so that their immediate products are soon prominent, much as is indicated by the longitudinal section of a young foliar apex shown in fig. 19. The general effect thus maintained is the display of a seemingly 'limited' apical meristem which does not assume the form of a tunic. The third feature is the generally high level on a leafy shoot to which cell-enlargement is evident beneath the apical meristem, so that the latter merges downwards into an evident corpus. With this is coupled the progressive advance of cell-enlargement abaxially in the forming leaves. In the case in hand, a definite change in the display of apical meristem and in the positions of lateral primordia has been noted repeatedly when flowering is prefigured. As is shown by the protruded exogenous shoot depicted in fig. 20, the lateral primordia no longer closely beset the summit of the shoot from which is extended backwards a small-celled meristematic tunic covering a parenchymatous massive. After prophyll-formation, the lateral primordia no longer show the earlier dominance in growth. Cell-enlargement duly dominates them and they mature as bracts of limited stature ; with meristem persisting in the basal adaxial positions which are lettered C. Flower-primordia duly arise in these positions : their products show the same general phenomena as are mentioned immediately above.

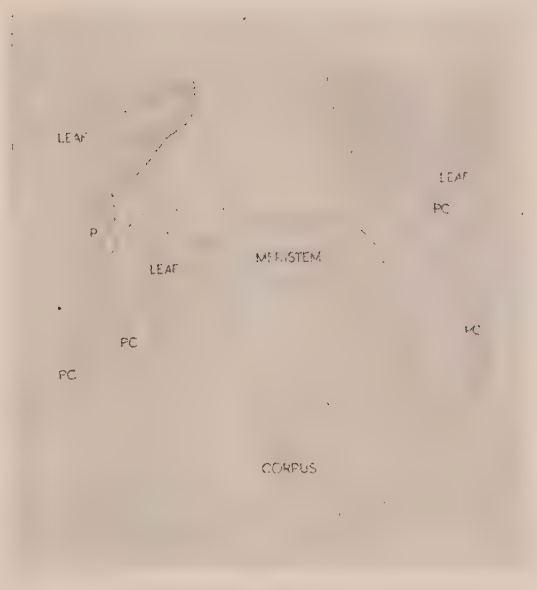


FIG. 19.

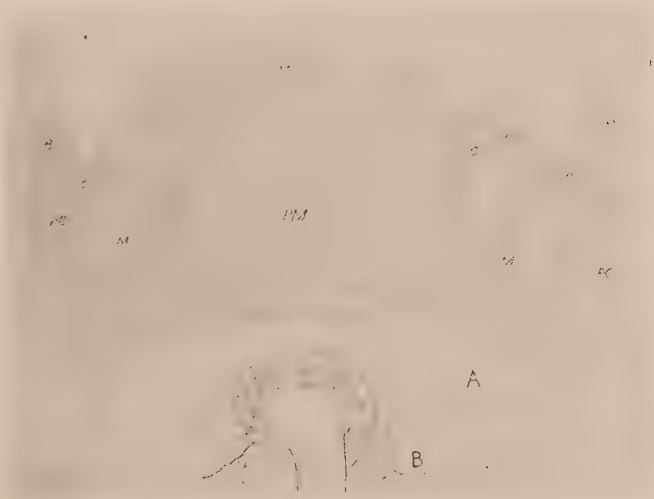


FIG. 20.

So far, it is by no means clear whether the inception of flowering involves *both* a redistribution of apical meristem and primordia *and* an increase in meristematic tissue. This is a matter on which a proper statement will be given as records and actual measurements are correlated. But the evidence so far indicates that there is increase in the meristematic tunic from androecium-initiation onwards, reaching pronounced proportions as gynaeceum arises.

This statement may be closed by a brief reflection upon its major contention and on the general direction of physiological enquiry which it seeks to indicate. If the few observations now selected for special mention are widely paralleled, then modern flowering is a progression towards the retention of youthful tissue which is the direct product of initial meristem. This progression may be carried forward to various stages, much as a ladder may be climbed to various heights. The progression may suffer reversal, much as the advance of a climber may proceed by descent. The upward progress may be by gradual or irregular steps : the downward steps may not be the exact reversal of those first taken.

At present little more is known on the experimental side than that the inception of flowering can be affected by the intensity and periodicity of light, and by vernalization with its temperature relationships. There is still no body of observation whereby one might support or refute the notion that these factors may, as it were, set finally the course of floral development. But one hopes that this matter will be fully pursued.

On the other hand, there have been sporadic speculations regarding specific morphogenetic factors, as apart from a general change of state ; one for flower-initiation, another for androecium, and so on through the gamut of floral organs. The writer feels that this is deceptive and that behind the march of morphological and histological changes which characterize modern flowering there may be one basic controlling factor whose incidence and intensity of action may increase or wane throughout development. He believes that, in its last terms, this master factor must reside perpetually within the body corporate ; and this irrespective of the actions of external factors. Having in mind that an embryo is initially an indivisible mass of youthful small-celled meristem, he thinks that the intimate physiological study of embryos and of forming seedlings will furnish a solid background against which the events of flowering may duly be judged aright. According to the opinions here conveyed, ovulation and its immediate consequences need not mark the sole available path to the formation of a juvenile plant in modern Angiosperms, nor need flowers be their only loci of embryogeny.

Discussion.—

Mr. W. C. WORSDELL remarked :—In opposition to Prof. McLean Thompson's general thesis, I regard the floral and vegetative structures of the Carob as due to secondary modifications ; the ancestry would probably reveal a simpler structure. Ontogenetic physiological processes will account for some of the floral structures, e.g., varied position of stamens and carpels and terminal legume ; but ontogeny and physiology can never solve the problems as to the real nature and origin of any modified structure, e.g., the legume. The speaker's view that such

secondary apparent structures as the ' inferior ' ovary and extra-axillary inflorescences (*Solanum*) can be satisfactorily accounted for by the ontogenetic development alone is strongly objected to. Comparative morphological and teratological method of research can alone explain them.

Dr. M. A. H. Tincker.—An interpretation of flowering may also be approached physiologically, by bringing the phenomenon under control when attention can be focused on the meristematic tissues. With the race ' Biloxi ' of the soya bean, short days of 10 hours' duration accelerate flowering but check elongation and vegetative growth ; long daily periods of light permit vigorous growth and flowering is materially delayed or prevented. Murneek and Gomez (Miss. Bull, 242, 1936) found that under short days the conical apical meristem consisted of a small group of uniform isodiametric cells larger in size, but fewer in number than those found in the cylindrical meristem of plants under long days. The development of the floral and vegetative buds in their earliest phases was similar ; divergence was observed when bracts appeared. When leaf primordia were visible, differentiation of the tissues began in the plants receiving long daylight. As judged by the larger number of meiotic figures, cell division proceeded generally under long days, but under shorter periods was limited.

The most striking difference I observed in soya beans, runner beans and clovers, was in the cell-elongation behind the meristem, it was much greater under long periods of light. Rapid cell division was maintained as the products of this process were removed by elongation and subsequent differentiation. Under short daily periods cell elongation was checked and the number of cells produced was also restricted. In the larger soya bean plants, under long days, with more branches but no flowers, there was greater total mass of meristem.

In red clover under long days flowering took place after elongation and branching ; but under short days with this plant also, meristematic activity and elongation were restricted.

Like our indigenous grasses, a late-ripening winter wheat, ' Hen Gymro ', continued growing steadily without flowering under short periods of light, to produce many branches each with its meristem. In time more meristematic tissue was formed under short than under long days, which permitted elongation of the inflorescence stalk and subtending leaf-sheaths and flowering, accompanied by limitation of the tillering, followed by earlier senescence. Manipulation of the external factor modified the development of the inflorescence to give interesting structures showing the inter-relationship between, and potential plasticity in development of, glumes, paleae and leaves. Secondary inflorescences occasionally developed. Under short days, in this wheat reduction division, the strictest criterion of ' flowering ', was very infrequent ; in other wheats flowering was merely delayed. (See Tincker, M. A. H., and Wadham, S. M. and others in Ann. Appl. Biol. xix, 1932.)

The meristematic cells are probably conditioned by a balance of hormonal action, including that of (*a*) auxin and similar hormones, and (*b*) hormones as yet not isolated and characterized chemically, but referred to tentatively as florigen by those botanists who consider the limited but accumulating evidence sufficient to justify their recognition.

PROCEEDINGS OF THE GENERAL MEETING
24 February 1944

held jointly with The Zoological Society of London

Mr. A. D. Cotton, O.B.E., President,
in the Chair.

The Proceedings of the Special General Meeting held on Thursday, 10 February 1944, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last meeting :—Dr. Gregorio Bondar, Mr. F. Burke, Professor G. D. Hale Carpenter, M.B.E., Mr. H. A. Hammond Dunn, Mr. J. Insch, Mr. A. Simmonds (Royal Horticultural Society), and The Under Secretary of State for India.

The following Fellow signed the Obligation in the Book of the Charter and Bye-Laws and was admitted :—Dr. William Homan Thorpe.

The President reported the death of Mr. Frederick Chapman, Associate of the Society.

The following candidate was balloted for and elected an Associate :—Curtis Dudley Routh.

The President reminded Fellows that under Bye-Laws, Chap. 8, Sect. 1, Fellows are entitled to make recommendations for new Members of Council and Officers.

The following communications were read and discussed :—

Dr. W. H. Thorpe. Some problems of Animal Learning. (Discussed by Dr. Marie Stopes, Professor F. G. Gregory, Dr. P. W. Richards, Dr. R. Melville, Lieut.-Col. W. P. C. Tenison and Dr. M. A. Brett ; Dr. Thorpe replied.) [Printed below.]

Professor F. G. Gregory, F.R.S. Vernalization. (Thanks were expressed by the President.)

SOME PROBLEMS OF ANIMAL LEARNING.

By W. H. Thorpe, Sc.D.

When your Secretary did me the honour of asking me to address the Society, I thought it would be well to try to find a subject which might interest both those who are primarily laboratory workers and those whose main concern is field observation. I hope that in choosing 'Some Problems of Animal Learning' I shall have achieved this aim. At any

rate, I am convinced that the subject is one which offers many promising lines of investigation,—one which has not hitherto received the attention which it deserves and which needs emphatically the co-operation of the field observer and the laboratory worker ; or, preferably, a combination of the two in the same person.

Obviously the subject of animal learning is a very big one, and I shall select, perhaps it may seem rather arbitrarily, certain topics which appear to me particularly interesting or seem to offer special promise. I have already reviewed the subject more extensively, as regards the Arthropoda, in a recent paper (Thorpe, 1943–44).

Firstly, a couple of definitions are necessary. *Learning* implies *that process within the organism which produces adaptive change in individual behaviour as a result of experience.* This being so, *Habituation* may be regarded as the simplest type of learning. The word '*habituation*' is here used solely in its technical sense, implying a simple learning *not* to respond to various mild shock or 'warning' stimuli, such as a flickering shadow or mechanical shock, when these are repeated without 'reinforcement' (to use Pavlov's term) by any unfavourable or harmful result. Thus the word does not imply habit formation in general, but rather the reverse. We may, therefore, define *habituation* as *an activity of the central nervous system whereby innate responses to mild shock and warning stimuli wane as the stimuli continue for a long period without unfavourable results.*

Habituation

Humphrey, working on the snail, *Helix albolabris*, has provided what is perhaps the best account of the habituation process. When the substratum on which the animal is walking is subject to a mechanical shock the tentacles are at once withdrawn for a short time. If the mechanical shock is repeated at regular intervals and the intensity of the stimulus maintained exactly constant, the extent and duration of the tentacle withdrawal steadily decreases till finally the animal has become absolutely indifferent to the stimulus. If, during the course of an experiment, the intensity of the stimulus is increased, then the response reappears for a while only to wane again on repetition. As Humphrey pointed out, habituation, or something very like it, is found in organisms of all evolutionary grades. Besides habituation to a shock stimulus there are many cases of habituation to sound. Thus, as long ago as 1887 the Peckhams showed enduring habituation of the spider, *Cyclosa conica*, to the sound of a tuning-fork. An auditory habituation is also known in the cricket, *Lyogrillus campestris* (Baier, 1930). Another type of habituation is exemplified in Wigglesworth's work on the preferences of the human louse, a striking instance of habituation to the texture of the substratum, the animal showing a preference for a rough as opposed to a smooth surface, the preference manifesting itself by a greater rate of change of direction when the insect accidentally wanders in the experimental chamber from a material made of wool to one of silk. But if it has been kept on the smoother surface for some time this preference disappears, the insect apparently having become habituated to the new conditions.

In the course of my own work, I have come across some rather remarkable instances of habituation to odours. Here we have to be particularly careful to distinguish between habituation proper and the change in behaviour due to adaptation or accommodation of the sense organs concerned ; although the work of Dethier (1937) suggests that insect chemo-receptors may not accommodate nearly as readily as might be expected. The experiments, which have already been published in full, were concerned first with an ichneumonid parasite, *Nemeritis canescens*, whose behaviour is particularly dominated by the olfactory sense. The experiments were performed by means of an olfactometer of the McIndoo type, which consists essentially of a Y-tube having a light placed on the main axis of the instrument to cause the insects to move up the stem of the tube. Equal air currents are drawn down the two arms of the Y and so through the stem, and the odour to be tested can be put through either of the arms at will and the response shown by the number of insects going to the right or left, as the case may be. It was shown that the *Nemeritis* are repelled by the odour of cedar-wood oil, some 80 per cent going to the blank arm when the odour of cedar-wood oil is being drawn down the other arm. But if the insects have been kept for a period of about two days in a chamber through which air bearing the odour of cedar-wood oil is being drawn and are then tested in the same way in the olfactometer, a great difference is apparent. The repellent effect of cedar-wood oil has now dropped from 80 per cent to something like 55 per cent, and this acquired tolerance is maintained for a number of days, only fading out gradually and requiring some ten days to get back to the normal level.

While habituation is a very simple type of learning, it must not be forgotten that it may produce results which appear, at first sight, to be highly complex. Thus, in my own work with *Drosophila melanogaster* (Thorpe, 1939), it was shown that not only could the repellent effect of an odour—in this case peppermint—be reduced by previous sojourn in a peppermint-containing atmosphere, but that it could be entirely reversed so as to give a positive chemotaxis. Now this, at first sight, appears to be something more elaborate than habituation, since the response swings over completely from repulsion to attraction. In actual fact, it appears from later observations that the most probable explanation of these results is to be found in the fact that the peppermint used contained small quantities of ester as well as menthol. Menthol is a repellent, and is probably alone responsible for the repellent effects manifested at first exposure. The ester, on the other hand, is attractive, but its attractive effect is at first completly masked by the presence of the menthol. But continued exposure, by analogy with the *Nemeritis* —cedar-wood oil experiments would almost certainly result in habituation to the repellent component with the consequence that the attractive component would now be free to manifest its effects, and we thus get the *appearance* of a complete reversal from repulsion to attraction, whereas, in fact, habituation alone is responsible. Recently Cushing's (1941) results comparing the oviposition behaviour of *Drosophila* reared on a medium containing fungi, with those reared on an artificial medium, have given valuable confirmation of my own conclusions on pre-imaginal

olfactory conditioning in this insect ; here, too, it seems possible fully to explain the observed effects on grounds of habituation alone, assuming that the artificial medium gives rise to a mixed odour comprising both attractive and repellent components. However, other results with *Nemeritis* indicate a higher grade of learning, and the possibility appears from Dr. Crombies' recent work (1944) that in the blow-flies, *Calliphora erythrocephala* and *Lucilia sericata*, a positive response to pure menthol may be induced. Experiments on a larger scale would be necessary to render this result statistically beyond question, but if it is substantiated, the results could no longer be regarded as indicative of habituation alone and would more appropriately be discussed under the heading of ' latent learning '.

In experiments which involve exposing insects to the vapour of essential oils one has always to be on guard against the possibility that the substance used accumulates on the sense organ, so interfering with its action as to give an appearance of habituation. This seems very unlikely where the effect is of long duration as with *Nemeritis*. When, still further, an effect can be produced in the adult as a result of treatment as a larva—as in ' pre-imaginal conditioning ' of *Nemeritis*, *Drosophila* (Thorpe, 1939), *Calliphora* and *Lucilia* (Crombie, 1944)—the possibility of receptor injury being involved seems exceedingly remote. In all experiments of this kind one of the primary difficulties is the standardization of incentives and the avoidance of any possible irritant effect due to too high concentrations. Dr. Crombies' work has done much to show how such difficulties may be overcome.

There is much apparently complex behaviour among ants that may, in fact, involve no more than habituation. It is well known that, as recorded by Fielde and a great many other observers, many species of ants exhibit antagonism to ants of other species, and even of other colonies of the same species. It is clear, from the work of Bethe, Fielde (1904) and others, that this antagonism is mainly, if not entirely, a question of distinctive odour. According to Fielde (1901) the antagonism of workers of an ant, such as *Stenamma fulvum piceum*, is aroused by any ant odour which a given worker has not previously encountered individually. But it is also well known that under various conditions artificial mixed colonies of ants can be established, and that once the individuals of the two species or races or nests, as the case may be, have become thoroughly accustomed to one another, the new composite nest is often a stable and permanent entity. Brun (1912) has shown that the circumstances in which there is a good chance of an artificially mixed population of ants becoming rapidly ' allied ' are as follows :—(1) When both parties are brought into an equally difficult or unusual situation ; (2) when both groups are in approximately the same numerical strength and one group at least being in possession of numerous brood ; (3) in the presence of fertile queens ; and (4) in the presence of a powerful common enemy. Now it is clear from Brun's experiments that these results cannot be due to a simple associative olfactory conditioning between the individuals of the two groups. That this cannot be the explanation is also suggested by some as yet incomplete and unpublished experiments of my own on *Acanthomyops flavus*. If, then, typical

'associative learning' will not explain such observations, on what basis can they be interpreted? Fielde's explanation involves very elaborate psychological concepts. She says: 'Any distinctive odour to which an ant is accustomed and with which it associates security and satisfaction is attractive to it, while ant odours to which it is unaccustomed excite alarm and hostility in proportion to their strangeness'. The theory, though conceivably true of ants in some instances, clearly does not apply to the conditions which obtain in the four situations instanced by Brun (above). These ants are certainly not experiencing 'security and satisfaction'. No; what is to be noted about all these sets of conditions under which permanent mixed colonies can become established is that there is, in every case, some distracting over-riding feature which, by its greater urgency, inhibits the normal pugnacity for a period, just as the bee-keeper when mixing stocks of bees distracts them by sprinkling them with dust, so that the cleaning reflexes for a time dominate all else. During such period the process of habituation is at work and quickly dulls the strangeness of the new odour, so that it becomes accepted ('habituated') as the normal background of the new environment, and so no longer gives rise to animosity. It seems highly probable that 'habituation' will also account for instances of acquired tolerance in other hymenopterous groups. P. Rau (1928) records much the same phenomena as between rival queen *Polistes* wasps, and Stöckert (1923) says that rival sister queens of *Halictus* 'may compose their differences' and establish a colony on the basis of dual monarchy. Finally, to return to ants once more, it is noteworthy that Fielde (1901) comments upon the increasing 'tameness' of ants which are frequently handled, and Donisthorpe (see Hingston, 1928, p. 187) tells how a colony of *Myrmecina graminicola* kept in confinement for many years 'lost their natural timidity'.

This, I think, will be enough to show how very far-reaching the effects of even the simplest type of learning may be and how much one must be on one's guard against bringing in unnecessarily complex interpretations.

The Biological Significance of Habituation.

Now, why is this simple type of learning so universal in relation to mild shock and warning stimuli of a generalized nature? I think an explanation may be sought along the following lines.

Some animals have precise instinctive responses to the appearance of that particular species or kind of predator which is most dangerous to them. Thus, Lorenz showed that grey geese gave the warning call and took avoiding action instinctively when a model resembling a bird of prey was drawn on wires over the enclosure in which they were kept. Lorenz pointed out that the maximum response was produced by a model which, in size and proportions, resembled as nearly as possible the sea eagle (*Pandion haliaetus*). There has been much work recently by Nice and ter Pelkwyk, Rand and others on the instinctive recognition of enemies by birds. The only object to which Nice and ter Pelkwyk's hand-reared song sparrows showed alarm was a model of an owl or a stuffed owl specimen. There seems little doubt from this work that

the song sparrows recognize owls instinctively, but that the appropriate response to other enemies, such as cats and snakes, must be learnt. That this is not by any means a general rule is shown by Rand's (1941) work on the Curve-billed Thrasher, a North American bird of the thrush type. Here the response to most enemies had apparently to be learnt, but there does seem to be an inborn response to a snake, a response which, at its maximum intensity, can be elicited by gentle, undulatory movements ; for example, by an imitation rubber snake appropriately moved. But the response to the rubber snake soon fades, whereas the response to a real snake does not, showing that the response is, in some way, to a pattern of stimuli, the core of which is the gentle, undulatory movement of a long flexible body. But this instinctive response to a particular species or kind of predator is probably rather rare. Most animals, particularly small or defenceless animals, are subject to a great variety of dangers from many kinds of predator and from other causes, and for them a specific instinctive response to each kind of predator and to any and every danger is out of the question. Therefore, instead of, or in addition to, any specific response, they have an instinctive equipment whereby they tend to take avoiding or self-protective action to (1) a wide range of stimuli which are likely to be signals for danger, especially any moving object ; (2) any stimulus or situation which is strange ; (3) any stimulus at an unusually high intensity. This mechanism with its wide scope ensures that they are on guard against most of the usual risks of life. But, obviously, sensitiveness to such a wide range of stimuli would, if the response was completely automatic and unvarying in intensity, make life impossible. Hence the need for some form of learning which saves the animal from wasting its energies in responses to stimuli which experience shows to be harmless or of no significance. Habituation exactly meets this need and is well-nigh universal. All of you will be able to think of examples. Let me quote one from a most interesting paper by Crane (1941) on the crabs of the genus *Uca*, on the west coast of Central America. These fiddler crabs, as they are popularly called, have a great variety of enemies, yet they are adept at escaping them all, while wasting as little time as possible in their burrows. ' Noises ranging from the cries of their bird enemies to the shouts of human beings, whistles, cannon fire and dynamite have no meaning for them. Neither did the passing of butterflies or wind-blown leaves within an inch or two of their eyes, but a bird flying over them within twenty-five feet, or a plane within, say, two hundred feet, was the alert which sent all crabs scurrying to the mouths of their holes, where they froze, poised for instant flight within.' The ' take cover ' signal was the approach of a bird either on foot or wing within ten to twenty feet (depending on both bird and crab), and the approach of a human being within, on the average, thirty feet.

We have not much evidence, in those cases in which there is an inborn response to the specific pattern of a predator, as to the effect of repeated stimulation without any injury following. It is quite true that repeated display of the model of an owl to young song sparrows may cause a drop in number and frequency of alarm notes over a period of fifteen minutes, and this looks very like habituation. On the other hand, this fading of the

response of the song sparrow to predators did not last, and when they were tested again a day or two later it was back at its original intensity. Thus, though there may be short-term habituation, Nice and ter Pelkwyk say that ' memory has been shown to be of great importance in enemy recognition ', and that even the memory of circumstances connected with a *single* occasion when an owl model was presented will cause alarm which persists after several months. Thus, one young song sparrow, which had been brought into a room in which a stuffed owl was placed on the corner of a piano, showed strong alarm even months afterwards, when brought into the same room, even though the owl was not there ; the alarm evidently being associated with the particular spot where the owl model had once been. Similarly, Lorenz's (1939) account of his experiment with the response of geese to hawk models suggests that the reaction, far from showing habituation, is highly persistent. So much so, that even though never reinforced by any harmful result the response remained so intense that the experiments were eventually brought to an end by the birds taking avoiding action as soon as they saw Lorenz or his assistant climbing the tree ladders prior to the commencement of an experiment. The geese had come to associate this act with the subsequent appearance of the hawk models in the sky. Strausz (1938), on the other hand, reports fading of responses to mounted owls and hawks, but in these cases it does not appear certain whether the response was inborn or acquired by learning.

It seems then that, as we should expect, habituation is almost universal in connection with responses to mild and generalized warning stimuli, but absent in those rather rare or exceptional cases where avoidance of danger is based on inborn response to the pattern of a specific predator.

The rôle of habituation has been emphasized in relation to ' negative reactions ', *i. e.*, avoiding and fright responses, because it is in this connection that it first appears in phylogeny, and it is here that its importance is greatest and is most clearly seen. But similar considerations presumably apply to positive reactions, *i. e.*, those which have as their goal the satisfaction of some need, such as the getting of food. In those monophagous or oligophagous animals of specialized feeding habits in which the food-getting behaviour is released by some complex or highly specific situation or set of stimuli, it is inconceivable that habituation could operate to any considerable extent without disastrous results to the animal. An animal that ceased its food-taking reactions because, for a while, its attempts proved unsuccessful would, indeed, be in a poor way. In order to live it must persevere. Habituation in such a case would obviously be biological nonsense. With polyphagous animals of generalized feeding habits, on the other hand, the environmental situations which release feeding behaviour are probably very general and non-specific (e. g., the pecking behaviour of a young chick). The animal has to learn from among a great variety of objects which are edible. This process is probably not only a matter of associative learning on the trial and error principle, as is usually assumed ; on the contrary, there is little doubt that here, in addition to positive association, habituation also plays its negative part, causing objects and situations which fail to give any satisfactory sensation, or any advantage, to be more and more neglected.

It may be that eventually habituation, the inhibition produced by the satisfaction of a need, and the phenomena of 'experimental extinction' and 'internal inhibition' will all turn out to be forms of the same essential process. But much more work will be necessary before we can dogmatize on this point, and the subject could hardly be discussed now.

'Latent Learning or Exploratory Learning.'

Another kind of learning about which I wish to make a few remarks is the type which has been called latent learning—learning without patent reward. Latent learning is, in some respects, a rather unsatisfactory term, but it is now being so extensively used that there is much to be said for retaining it. Latent learning based on olfactory cues may possibly occur to some extent in animals such as insect larvae which lack the more complex kind of distance receptor (Thorpe, 1943–4 ; Crombie, 1944). But typically latent learning is more especially characteristic of animals which explore their environment without the satisfaction of any immediate reward, but by their exploration secure information which may afterwards be of use to them in a number of contexts, for example, in food-getting, in escape from enemies, or in finding their way home. Perhaps this type of learning is best described by giving some examples. Blodgett (1929), Elliot (1930) and Tolman and Honzik (1930) showed that rats which had had daily unrewarded runs through a maze on ten successive days, when presented with food in the food-box displayed a very striking decrease both in errors and times of running as compared with a control group (see also Haney, 1931). Maier (1932) showed that a very simple maze may be entirely mastered through random exploration ; the introduction of a reward, therefore, merely causes the animal to demonstrate its learning. Further confirmation of this was provided by Daub (1933) and Herb (1940). The fully 'trained' animal, once it has found food in one part of the maze can then go direct to that point from any other part of the maze in which it is placed. But how far is latent learning entitled to the distinction of a separate category and what are its essentials ? And if it is a distinct type, how is it to be related to the other categories of learning ?

It seems that latent learning involves the following three separate elements which are characteristic, in that they are not necessarily found in the simpler types of learning. It is learning without specific motivation by any of the primary needs ; it results in a kind of 'transfer of training', whereby the animal can use its learned behaviour in response to changed motivation ; and it connotes a faculty enabling the animal, without any trial and error process, to 'select' or attend to certain parts of the previously learned whole as a signal for the whole or in relation to certain specific needs.

With regard to the question of motivation it might be objected that there can be no action or learning without it, and that the animal in the maze, if neither seeking food nor motivated by one of the other primary needs, is trying to get out ; in other words, is activated by the 'need' to escape. To use Russell's (1935, 1938) terminology, the whole environment has escape valence. Now this may well be true in part—the animal may be in effect exploring its environment as a result of its

need for food or escape. But this does not mean that the process can be regarded as an example of trial and error learning, for the rat, by its efforts, does not get food nor does it escape (see Haney, 1931 ; Daub, 1933 ; Herb, 1940) ; therefore, on the pure trial and error principle there is no basis for learning : yet it does learn. Actually what we have here amounts to much the same thing as ' exploration for its own sake '. We may say that ' the animal tends to explore its surroundings ; that it has a tendency to investigate its environment. It is this phenomenon to which Pavlov refers as the ' investigatory reflex ' ; an inappropriate term, in that if this complex behaviour is described as a ' reflex ', the term ' reflex ' loses all precise meaning and becomes a synonym for response. ' Latent learning ' may also be an unfortunate term, but we shall make a great mistake if, having dubbed the phenomenon ' exploration ' or ' investigation ', we leave it at that and assume that all is fully understood and the observations of little significance. On the contrary, they are of the greatest significance ; for, in describing a piece of behaviour as ' exploratory ' or in speaking of ' an exploratory instinct ', we are at once placing the organism on a relatively high behavioural level.

Indeed, we must expect to find that animals which are capable of any *complex* homing behaviour are, *mutatis mutandis*, psychologically in advance of those which are not.

As an example of what appears to be ' latent learning ' among the insects, let us take the nuptial flight of the queen honey-bee, or that of the young worker just prior to the commencement of outdoor foraging duties, where one or two short ' orientation flights ' a little while before departure are all that is needed in preparation. Such a performance, considered in terms of maze learning, is seen to be an astonishing achievement. Wolf describes how a worker bee, taken from the hive and transferred in a box to any point within the normal foraging area, is able to recognize its location and find its way back to the hive without difficulty.

To sum up : Observations and experiments on the homing of animals in the field cannot, of course, be expected to yield readily the precise evidence of latent or exploratory learning, which, when applied to suitable cases, laboratory methods can provide. But where we find a homing response to a complex environmental pattern very rapidly learnt by the individual as a result of specific orientation excursions—yet, at the same time, a response which is to some extent flexible and adaptable as the situation requires—we have reasonable grounds for the assumption that powers essentially equivalent to those concerned in latent learning must be involved.

This matter of exploration raises an interesting theoretical problem ; one put, to some extent, by the facts of habituation, but much more acutely by these exploring animals. It is that *anything strange* within very wide limits, or a *familiar object in a new context* is responded to either by an avoiding reaction, which may be rapidly extinguished by habituation if no dire results follow, or by cautious investigation. This implies a highly organized background of the familiar against which something new stands out as possibly dangerous and something to be investigated. The investigation completed, this new object is ' built in '

to the perceptual world as something which can henceforth be ignored or which can be utilized later, by ' transfer of training ', in a different context.

In the ' lower ' animals the perceptual world is preponderatingly instinctively determined, and latent learning, if it occurs, probably plays only a relatively small part. In the main the world of these animals consists of (*a*) fairly exactly defined favourable stimuli or situations which release positive and specific responses concerned with food-getting, mating, etc., modifiable to a slight extent by associative learning, and (*b*) rather vaguely defined warning stimuli and situations which release avoiding reactions on which *habituation* (and, to a lesser degree, associative learning) works to produce modifications advantageous for the life of the animal. In addition (*c*) there may be, in exceptional cases, specific enemy recognition of the stereotyped kind described in the previous section.

In the ' higher ' animal, on the other hand, the perceptual world is, to a lesser extent, determined by instinctive dispositions. Although habituation of generalized warning stimuli may still play a large part, e.g., Kuhlmann (1909), complex behaviour patterns are now to a greater extent built up by a process of ' taking notice of ' or ' investigating ' a large variety of environmental factors and combinations of factors which have not any specific valence for the animal to start with. This building up, no doubt, proceeds by all types of learning, but probably much of it is due to something very like that which, when seen in a rat in a maze, we call latent learning based on a tendency to ' explore the environment '. This is not to deny the value of the concept of valence as ' meaning for action ' set forth by Dr. E. S. Russell in the appendix to his last presidential address to this Society (Russell, 1944). On the contrary, I regard this concept as a valuable one. Certainly in many animals by far the greater part of the behaviour in certain situations is governed by this principle. Nevertheless, even with creatures of such stereotyped behaviour as birds there is evidence of something corresponding to latent learning and even to true insight learning (Lorenz, 1935 and 1939 ; Teyrovsky, 1930 ; Hertz, 1926).

Imprinting.

Those acquinted with the literature of bird behaviour will remember that Lorenz (1935, 1937), following on the work of Whitman and of Heinroth, has emphasized the fact that besides conditioning in the broad sense, there is found among birds a very peculiar type of learning process. This process he called ' Prägung ' ; translating it into English by the term ' Imprinting '. Imprinting, which differs in some respects from associative learning, results in the acquisition of the biologically ' right ' object of social reactions by conditioning them, not to one fellow member of the species, but to the species pattern as such. It is found in those birds which do not recognize their own species instinctively, but must be appropriately ' conditioned ' in early life. Imprinting clearly does not fall neatly into any of the categories of learning already discussed, although it has affinities with both habituation and latent learning.

Where the species is characterized by some fairly simple and striking combination of characters (e.g., a simple contrasting pattern of two or three colours, as in the wing pattern of ducks) the recognition of the species is often instinctive or inborn. Where such a *simple* specific pattern is lacking the hereditary mechanism for recognition seems, in some few species at least, to fail and the instinctive recognition is completed or replaced by the imprinting process.

Imprinting, as defined by Lorenz, is peculiar in the following respects :—

(1) The process is confined to a very definite and usually very brief period of the individual life, following shortly on emergence from the egg. As a result, the young bird comes to accept as its proper companion, representing the species, the first relatively large moving object it perceives, i.e., in normal circumstances, its parent.

(2) The process once accomplished is very stable, if not totally irreversible ; so that for the rest of its life the bird's reactions *appear* purely instinctive.

(3) The process is often completed long before the various specific reactions to which the imprinted pattern will ultimately become linked have been established.

Now what evidence is there for any type of imprinting among the insects ?—for it is among the insects, as, apart from the birds, the group of animals most completely equipped with complex instincts, that we should look for a type of learning which is particularly associated with the maturation of instinctive behaviour patterns. Regen (1926), investigating the discriminative ability in regard to sounds of the grasshopper, *Thamnotrizon apterus*, found that males which had just entered on adult life and had not yet fully learnt to alternate with the normal chirping of the species, could be induced to sing in rhythmic alternation with artificially generated sounds over an enormous frequency range. Those adults, however, which had already learnt to sing in concert with their brethren immediately detected any attempt at imposture and were reduced to silence, no matter how closely (by human criteria) the artificial sounds approximated to the natural song.

Unfortunately, the account of these extraordinarily interesting observations does not give us all the data we should like to enable us to decide whether we have here a true case of imprinting. But there seems little doubt that something very similar is involved. That it can hardly be purely instinctive is shown by the great individual variation in song which wild *Thamnotrizon* display, and therefore with which individuals alternate in nature. But among other things we need to know whether males not exposed to the chirps of other males retain their generalized response or not. If not, presumably something in the nature of maturation of instinct during the life of the individual is involved as a basis for imprinting.

It may perhaps be permissible, as I have suggested elsewhere (1944), to extend the original definition of imprinting to cover the possibility of attachment not to a living object but to the immediate locality first perceived by the newly emerged organism, so that this particular area

becomes, by a similar process, the future breeding quarters of the individual. Here, it is true, we are on ground far less secure ; yet such a possibility is particularly suggested by a number of observations on the behaviour of solitary bees and wasps—all insects with very remarkably developed powers of vision and homing orientation.

Thus, P. and N. Rau (1918) and P. Rau (1934), writing on the localization of colonies of Bembecine wasps, says : ' The persistence with which *Bembix* adhere to the one location which we have watched year after year is astonishing. Truly their dissemination seems to be *nil*. Here the wasps of our particular colony have had at their disposal a pasture equal in size to six city blocks in which to choose their nesting site, yet year after year * they limit themselves strictly to two distinct corners of a " base-ball diamond ", in the middle of this field. The fact that each successive generation should show the same choice and the same persistence [in spite of interference from disturbance by baseball players] is all the more astonishing. In another vacant lot a mile away was another colony which, to our knowledge, persisted in like manner on a small area for three years [until their extermination by the erection of a building]—although just across the road from the lot was a large tract of vacant land thoroughly suitable to their needs.' From the accounts of the Raus, Peckhams and many others, there seems to be no evidence whatever that the limited distribution has any ecological basis ; it seems extremely probable that other parts of the field where the colony was situated would have served as well. This extraordinary restriction suggests, therefore, that the result of the first locality study of the newly emerged *Bembix* becomes imprinted with great force with the result that the spot is ' home ' for the individual for all purposes for the rest of its life. Before, however, we can accept the hypothesis we must bear in mind the gregarious instinct of this genus which may possibly, if all emerge at the same date, itself be the basis for their topographical conservatism.

But although the Bembecines provide the most striking example of this topographical conservatism, there are many other solitary bees and wasps, and perhaps some social wasps (e.g., *Polistes*) which seem more or less strongly attached to the place where their mother nested † and where their first locality study was made. Some of these colonies persist for many years. Thus one colony of the ' solitary ' bee *Andrena cineraria*, at Wootton-under-Edge, Gloucestershire, was kept under observation for nearly forty years (1876–1914) ; no other colony of the bee ever having been observed in the district.

One could continue to multiply instances and could digress along many other pathways, but I think I have said enough to show the interest of imprinting and to emphasize the fact that it seems to be a type of learning concerned with the maturation of an instinct, or perhaps rather as a sort of completion or fine adjustment by a special learning process of a rather imperfect instinct, not of itself quite adequate to the situation.

* Observations of a single colony over twenty years (P. Rau, 1934).

† Dr. O. W. Richards, who has an exceptionally wide experience of the habits of the Aculeate Hymenoptera, tells me that his impression is that this is the general rule.

In conclusion, I hope that in discussing this work on instinct and learning I have made clear how misleading either field observation or laboratory study may be alone without the corrective supplied by the other.

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PROCEEDINGS OF THE GENERAL MEETING
9 March 1944

held jointly with The Zoological Society of London

Mr. A. D. COTTON, O.B.E., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 24 February 1944, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last meeting :—Dr. L. H. Bailey, Professor D. H. Campbell, F.M.L.S., and the Carnegie Corporation of New York.

The President stated that an appeal to the Society had been received to present books to a certain Service Club in London. As there are no suitable books which can be spared from the Society's library, it had been suggested by the Council that if any Fellow had any well-illustrated works of general interest, to spare either botanical or zoological, he might care to send them to the Society's rooms for transmission to the Club in question.

The President announced that in consequence of illness Mr. C. E. Britton was unable to make the promised exhibit on behalf of Mr. H. Wallis Kew of Abnormal flowers of *Linaria vulgaris* with four bearded petaloid structures within the corolla-tube, and that the exhibit would come before the Society on a later occasion.

The following communications were read and discussed :—

I. H. Burkill, M.A. The early economic history of the tree *Mesua ferrea* Linn. (Discussed by Dr. Malcolm Smith.) [Printed below, p. 85.]

H. N. Dixon, M.A. A note on the phytogeographic relations of Sumatran and other alpine mosses. (Discussed by Mr. I. H. Burkill and Dr. J. Ramsbottom.) [Printed in full on p. 91.]

E. Browning and W. H. T. Tams. On the occurrence in Suffolk of a Western Mediterranean cavernicolous spider, *Meta bourneti* Simon (Araneae : Argiopidae.) [Printed in full on p. 94.]

E. Browning. On the males of a tick, *Ixodes hexagonus* Leach. (Acari : Ixodidae.) [Printed in full on p. 96.]

(The two papers were discussed by Mr. I. H. Burkill, Dr. Malcolm Smith, Mr. T. H. Savory, Dr. J. Ramsbottom, Professor A. Meek and the President : Mr. Browning replied.)

Dr. V. V. Tchernavin. The breeding characters of salmon in relation to their size. (Discussed by Dr. E. Trewavas, Dr. Malcolm Smith ; Dr. Tchernavin replied.) [This will be published in the Proceedings of the Zoological Society.]

Dr. A. H. Uggla. Jonas Carlsson Dryander (1748–1810). (Read by the Assistant Secretary. Thanks to Dr. Uggla were expressed by the President.) [Printed in full on p. 99.]

Before reading this paper, the Assistant Secretary referred to Dr. Uggla's work on the Linnaean Manuscripts, his Catalogue of which will be a very valuable contribution to Linnaeana. The following paper was first written in Swedish for ' Svenskt Biografiskt Lexikon ', and Dr. Uggla has made the English translation for the benefit of those who do not read Swedish. (The name ' Carlsson ' is an instance of the survival of the old form of surname in use in Sweden before the adoption of real surnames, about the end of the seventeenth century.)

C. G. Hansford. Contribution towards a fungus flora of Uganda, Part VI. (Read by Mr. E. W. Mason. Discussed by Mr. I. H. Burkill, Dr. J. Ramsbottom and the President.)

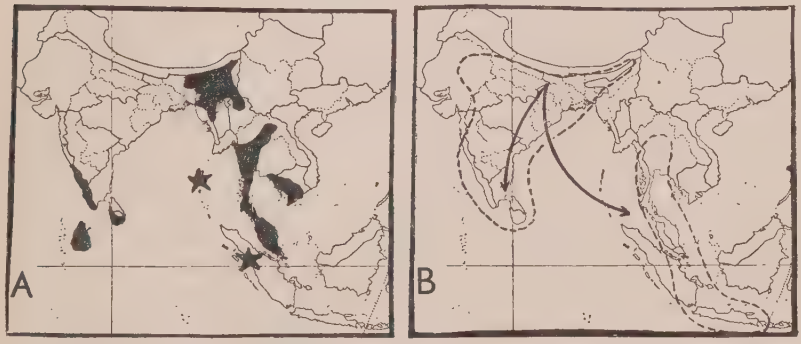
Mr. Burkill said that three of the fungi discussed in the paper would be withdrawn from it, as a separate and appended short paper with the title ' Three additional records of African Fungi '.

[Both papers are printed in full, see pp. 102 and 124.]

THE EARLY ECONOMIC HISTORY OF THE TREE MESUA FERREA (GUTTIFERAE).

By I. H. Burkill.

Mesua ferrea Linn. is a rain-forest tree of the parts of Asia to which the south-west Monsoon brings most rain. These parts are indicated in the map below. Troup has given the annual rain which they get as 80 inches and upwards, and the cold weather temperature as down to 40° F. (The Silviculture of Indian Trees, I, p. 23 ; 1921). Its timber is so hard that Ceylon gave it the name ' Ironwood ', and in dense forest it attains a height of 100 feet, with a clean bole of 60 feet (Foxworthy in Mal. For. Records, III, p. 135 ; 1925). When planted in the open it keeps its branches down to the ground and is very ornamental. The leaves are silvery below ; the flowers white, with numerous golden



Map A.—The natural distribution of *Mesua ferrea*.
Map B.—The areas over which names of sanskritic origin rule.

anthers, are three inches across, are carried conspicuously at the tips of the branches and have a strong but very delicate scent.

India took the tree into cultivation at an early date, planting it where the protection of man from competition and the provision of water enabled it to grow.

The following is a list of current vernacular names, not a complete list, but of those essential for the first part of the argument that I am developing :—

Hindi : nāgarkeshar, nāgkeshar, nāgkesar, nāgeshar and keshar.
Bengali : nāgkesar and nāgesar.
Mech : nagshar.
Assamese : nahor.
Uriya : nagokesoro and nageshwar.
Telegu : nagakesaramu.
Tamil : nagecuram and nagashap-pa.
Marathi : nāga champa.
Malayalam : nāgacempakan and nanga.

Kanarese : nāgakesara, kesara and nāga sampagi.
Singhalese : nā and nā-gaha (nā tree).
Siamese : nāk but and bun nāk ; kāi so and kā so.
Malay : nagasari and pĕnaga.
Sundanese and *Javanese* : nagasari or sari naga, often sari in brief.

All these names are derived entirely or in part from a *sanskrit* name nāgakesara, except sari ; and sari could have usurped the place of kesara by assonance. In a trio of south-western Indian languages, Marathi, Malayalam and Kanarese, the ' kesara ' is displaced by champa, sampagi and cempakan, which are names belonging to *Michelia*. Sometimes the ' nāga ' is dropped, but not as a rule. ' Nāga ' is a snake, usually the cobra, but also those partly anthropomorphic godlings of the pools which are worshipped in the villages of India ; ' kesara ' means hair and secondarily stamens with hair-like filaments. The sanskrit name, therefore, is to be translated Naga's stamens ; but to the simple villager was Naga's hair, for legendary Nagas were hairy monsters, particularly when aged and then most venerable.

It is obvious that those who used sanskrit highly esteemed what they called nāgakesara, otherwise they had not spread this name in such a striking manner to countries where sanskrit was not in common use. It is also obvious that they taught others to value it. Is it not strange, at least at first sight, that a tree not native of the parts of India where sanskrit was the language, should have a wide-flung sanskritic nomenclature outside the home of sanskrit even extending to countries where Mesua was native ? But this strangeness diminishes if it be granted that nāgakesara was not in the first instance the tree, but a trade product of the tree, namely, its stamens dried and moved about as merchandise, an import of the Gangetic plains which required a name and acquired such a reputation that the name was passed to the tree when it in turn became known.

The nearest sources whence the stamens could reach the bazaars of the centre of sanskrit were the forests of Assam, in which the tree grows so freely as to be today a valuable source of timber, and probably the supply was derived thence in the first instance.

The ' Susruta Samhita ', a great compendium of sanskrit medicine gathered together possibly not earlier than A.D. 600 from undateable records, prescribes nāgakesara and nāga buds in a variety of mixtures—a collyrium for the king's eyes, preparations to counteract poisons, cure hiccough, allay fever, suppress a desire for drink and in the treatment of insanity. I shall not try to analyse the prescriptions ; but, because Bishagratna's translation of the Samhita is scarcely indexed, I give these references to his pages :—I, p. 347 ; II, pp. 611, 693, 726 and 727 ; III, pp. 100, 194, 287, 293, 294, 295, 296 and 317. I take it that the allusion to the king's eyes implies that nāgakesara was costly, as one would expect.

Indian medicine still uses the flowers ; Dymock, Warden and Hooper (Pharmacograph. Ind., I, p. 170 ; 1890) suggest the medicament may be called a terebinthinate astringent.

The stamens carry the scent; and Boorsma, by a chemical examination, detected, in association with the scented oil, a tannin and a slightly poisonous bitter substance with an action on the heart (Bull. Instit. Bot. Buitenzorg, XXI, p. 4; 1904). This last is present in the oily seed in larger quantities and renders the oil unfit for food.

It was customary in the Gangetic plains to strew flowers over floors and seats, and to make the bed cool in the height of the hot weather by the use of petals and stamens of water-lilies, particularly of *Nelumbium*, whereof the scent was as grateful as the coolness, and the small white fragrant flowers of *Mimusops Elengi*. When so used, either might be called 'kesara' in sanskrit; but neither 'nāgakesara'. The stamens of Mesua took a place alongside these, not for the bed on ordinary occasions, but for the bed on which most money was expended—the ceremonial bridal bed—and took the name nāgakesara—Naga's stamens—by the occasion of their employment through the connection of Nagas with offspring; for the Indian prayed to the Nagas for children already in Vedic times and prays still, as hundreds of thousands of votive Naga stones, old and new, testify in its villages (see, for instance, Vogel, Indian Serpent Lore, p. 270; 1926). Thus it is evident that when sanskrit was a live language, nāgakesara held a place in the embroideries of a wedding, somewhat like that orange blossom holds with us, and, one may add, very firmly, as the persistence of the attribution to the Nagas in the many derived names demonstrates. The common people assuredly knew it from this use much better than as a drug.

It was essential that the dried stamens, in order to be useful on demand, should keep their scent, for which alone they were then required. The possibility of great deterioration caused me to write to Mr. R. E. Holttum to ask him to join me in an experiment by sending to me, through the post from Singapore, freshly dried stamens, that the consequence of keeping might be observed. This he did, writing in his covering letter, 'the stamens were gathered 27 November, and now, today, 1 December, 1941, have lost much of their scent in drying'. I received his letter on 11 March, 1942, and the stamens were scentless. I kept them in a corked bottle for another month, examining them from time to time, and could detect no scent until, in the end, I poured a little warm water on them when they, now $4\frac{1}{2}$ months old, at once gave off their delicious fragrance. This satisfied me. The stamens in the hot Indian night will release their scent on the warm perspiring skin.

Their bridal use led Indian poets to the happy fancy of tipping one of the arrows of Kama, the Indian Cupid, with Mesua wood.

We see today the tree spread in cultivation through the better watered parts of India. Manifestly it came to these parts after the trade in dried stamens had given the people some knowledge of it, for only after that had happened would the tree take its product's name. An early new home in the north of India must have been Chota Nagpur, where it grows well. Bana, an eminent writer of poetic prose at the court of the Emperor Harsha (regnal years A.D. 612 to 647 or 648), was a native of the northern edge of Chota Nagpur; and wrote in his 'Harsha Carita' (Oriental Trans. fund. ed., p. 112; 1897) as if fresh flowers were available

at the not very distant court of the Emperor, mentioning it as one would something well known ; and his way of referring to it suggests cultivation established long before. The poet Asvaghosa, about A.D. 120, had written of a ' nagavriska ' or Naga tree, which may have been it, and the Buddhists, apparently earlier, had adopted it, so that the Pali Buddhist literature arranges for imagined Buddhas to be born under it and meditate under it, and repeats stories of the respectful gift of flowers, and even of stamens, to holy men (references in Malalasekera, Dict. Pali proper names, I, pp. 669 and 1008 ; II, pp. 41, 43, 661, 751, 811, 1239, 1260 and 1305). They called it nāgakesara. Pali was the language of the Buddha Gautama ; and he died, as nearly as can be ascertained, in 490 B.C. Unfortunately the subsequent Pali buddhistic writings in which nāgakesara is mentioned defy precise dating, as compilations from sources of various dates, parts of the ' Apadana ', which is the most important of them, being as late, perhaps, as the second century of our era. They prove a knowledge of the tree by this name between about 300 B.C. and A.D. 200, and make reasonable the interpretation of Asvaghosa's ' nagavriksa ' as Mesua, as, indeed, interpreted by E. H. Johnston (in Journ. Roy. As. Soc., 1934, p. 118).

Some of the Pali references are to the tree near holy spots in Ceylon and one to it in the Himalaya, in places in which it is wild.

The tree has a few names in India derived from words meaning yellow, given because the stamens are yellow. Those in sanskrit are to be found in Monier-Williams' ' Sanskrit Dictionary '. One of them, ' kāncana ', apparently persists in Kanarese. These names have an interest here because they denote acquaintance with the tree in life when the stamens, which turn brown in the trade preparation, are yellow. Bana uses the words ' yellow kesaras ', obviously out of his knowledge of the tree in flower. I could quote other instances in which the older writers take the colour of a flower from its centre and not from its petals.

A tree so conspicuous would seem likely to have had a pre-sanskritic name in the languages of its southern home ; but none has been recognized, though there are two which suggest enquiry. The first is ' champa ', with its variants ; and it happens to be a name which Kittel (' Kannada-English Dictionary ', p. xxiii ; 1894) lists as likely to have entered sanskrit from dravidian sources ; but then it must have belonged to *Michelia* in the first instance, Mesua becoming Naga's champa by reason of the use of its scented flowers. The other is ' vēla ', which Dymock gives (op. cit.) as a malayalam name : but vēla is primarily various Capparids, while ' vēl ' is a name of Kama, into whose quiver the poets placed the arrow tipped with Mesua wood. If vēla originated from the connection with Kama, as seems probable, then this name is certainly younger than nāgakesara. And that having been said, neither ' champa ' nor ' vēla ' satisfy a search for pre-sanskritic names in the South.

In contrast there are areas eastward of the Bay of Bengal where no names are sanskritic, the greater part of Burma for instance, where among the Burmese the non-sanskritic name ' gangaw ' is exclusive. This name has toponomastically given the name to a village in the Pakokku district, which, in turn, gives its name to a subdivision—the Gangaw subdivision of the Pakokku district. Mrs. Milne, collecting words at Tawngpeng, in the Northern Shan States, for her Dictionary of English-

Palaung, obtained this name as ' kankaw '. In 1902 I enquired the name and uses of the tree in Moulmein, when I found it there in gardens ; and a Burmese, who told me that his folk liked the flowers for scenting coconut oil for the hair, called it ' gangaw '.

Moulmein belonged to the Talaings before the Burmese came down on Rangoon ; and the name for Mesua in Halliday's ' Mon-English English Dictionary ' (pp. 10 and 56 ; 1922) is ' anu ' or ' ahnu '. This name cannot be derived conveniently from ' naga '; which the Talaings turned into ' nait ' and ' neke '.

Yet the Talaings adopted a name for *Mimusops Elengi* from the sanskrit word ' kesara ', calling it ' kao kes ', i.e., hair flower or, if we like, stamen flower ; but as India had made chaplets for the hair from the flower from early times, ' flower for the hair ' might be understood, and no use for cooling beds even remotely suggested ; in whatever way ' kao kes ' be understood, it illustrates no more than acceptance of a sanskritic influence, not extending to adoption of the nāgakesara custom.

It was to the southward of the Talaings that the custom became established ; and I call attention to the circumstance of historic interest that the more remote from the Gangetic plains the coast across the water, the more, may I say sanskritic seems to have been the place of Mesua.

Malaysia is not rich in ancient written records, but an inscribed stone, the Ligor stone, found in Peninsular Siam and assigned to A.D. 775, declares in excellent sanskrit that a king, he who caused the stone to be cut, calling himself patron of the Nagas, claiming descent from a snake, had ' planted mangos, kesaras and other lordly trees '. Admittedly the kesaras that he planted might be other than *Mesua ferrea*—might be *Mimusops Elengi* for instance—but the context requires that these kesaras be lordly trees, which *Mimusops* scarcely is, and so distinctly suggests a connection with Nagas that assuredly the trees were Mesua.

The dispersal of Mesua as a cultivated tree in parts of Malaysia beyond the Malayan forests, to which it was natural, assures us that such planting as this exalted man did, others did, and the tree was conveyed to Java, by king or priest, for ornamenting the parks about palaces and religious buildings. It is today met with below 4000 feet in Java, from end to end, and is in Bali ; and as it usually does not run wild, its positions are of man's creating. It has been already shown that it has names in Malay, Sundanese and Javanese derived from sanskrit, and these show in themselves who were they who carried it. We are assured that it had both sanskritic uses, (i) as a medicine and (ii) as a scent for the bridal bed, for both persist, the former widely, the latter in the island of Madoera, which lies north of the east end of Java, and may well be conserved in Bali. In Madoera the stamens are put up in sachets for the express purpose (see K. Heyne, Nutt. plant. Ned.-Ind., ed. of 1927, p. 1081). The vocable ' kesara ' has been altered in this part of Malaysia to ' sari ', because sari means flower—a flower that is excellent, a flower in the sense of the flower of the flock ; but the assignation to the Nagas remains. To the medicinal use I will refer again.

The nearest way by ship to sea from the part of India where the nāgakesara habit must have arisen was down the Ganges ; and the nearest

coast across the Bay of Bengal that of Arakan. The Arakanese seem to have been in the van of that movement which brought the Burmese out of some back block of China into the northern parts of their present home, and the date of their coming was about the time of the Buddha Gautama. They were certainly at this time barbarous, and as conquerors were probably arrogant : it is natural to find in this a reason why adventurers coming by sea from northern India would find no ready and influential footing on the Arakanese coasts. Southward were the Talaings or Mon, who had journeyed the same way much earlier and settled. Their higher civic state made them open to tradé, but a little less to moulding. Southward again were simpler folk open to exploitation. It was among the last that adventurers from India carved out kingdoms, bringing with them all that they could of their way of living, including the nāgakesara habit. That is why the place of Mesua is more sanskritic in Malaysia than further north. The settlements in Peninsular Siam and Malaya possessing the tree in their forests gave it to Java.

A powerful hinduized Khmer principality, the principality of Fu-nan, grew up on the lower Me-khong, which, as the map A suggests, is one of the parts of the east where Mesua is natural. It would be strange if the royalty of Fu-nan had ignored Mesua, seeing how their rivals prized it ; and because those who live where they lived plant it much today, it may be assumed that Fu-nan royalty planted it, and search may be made for evidence of this in the names used by their successors.

The Chams, who grew to power as Fu-nan went down, have two names for the tree : one is ' hanyuei ', and refers to its scent (' hap ' or ' haup ' being fragrance) ; the other is ' kraik ' or ' krek ', which seems to be connected with a word for ' snake '. I put the suggestion out that in this second name is a shadow of the old use. These names are to be found in Aymonier and Cabaton's ' Dictionnaire Cam-Français ' (pp. 84 and 503 ; 1902), who quote the saying ' kraik is in new leaf in every month of the year ', which is true of Mesua in the south (cf. Foxworthy, op. cit. p. 136), but not of it in Assam, where it flushes in February chiefly. An Annamese name, ' vap ', which these authors quote, and the application of which C. J. Pitard confirms (in Lecomte, ' Flore générale de l'Indochine ', 1, p. 328 ; 1910), is the word for fragrance again. The Khmers use ' kralang ', which appears to be connected with ' kraik ' ; Aymonier and Cabaton give also ' tetrao '.

The flowers of Mesua and the stamens extracted from them enter into Javanese medicine in a considerable degree. Rumpf, in his ' Herbarium Amboinense ' (completed A.D. 1690), mentioned the stamens as used in Java, but the tree had not travelled to Amboina by his time. The uses today in Java are probably those of Rumpf's time and of long before.

With the sanskritic names that I have quoted, the Malays have two or three non-sanskritic names of no historic value ; and for the flowers as prepared for medicine the Javanese have ' changkok ', which is not sanskritic. ' Changkok ' denotes the similarly prepared flowers of *Schima Noronhae* also, the two being alternatives ; but the flowers of Mesua, as the more valued, are called in one form ' changkok mekar ' or ' Mecca changkok ', for the Mohammedans of Java attribute good things to Mecca.

This use of *Mesua* and *Schima* as alternatives leads to other names in common. Then, again, the usual vernacular name for Schima in western Java is ' pushpa ', which word is sanskrit, with the meaning of buds, flower-buds, that which has the property of opening. Why buds ?—buds for what purpose ? The ' Susruta Samhita ' prescribes ' nāga pushpa ', indicating the buds of Mesua ; and it appears as if when and where Mesua was scarce in Java, Schima was accepted ; and if that be so, the acceptance dates back to times when sanskrit was understood by enough of the population to fix the name. Note that ' pushpa ' is not for bridal beds, but for medicine.

The dating of events is difficult ; it is always so in Indian affairs. Working backwards, it is certain that the tree was popular in India in the seventh century of our era, and it may be assumed that the popularity was of long growth. It may be accepted that it had already come into cultivation by the second century and be assumed that the beginning of cultivation was some centuries earlier, as, though the Pali references do not date it, they seem to take it back, at least some way, towards 490 B.C. Maybe we shall know in time somewhat of the Assam trade-relations of the kings of the Ganges plains, and that will suggest the period of the trade in flowers which led up to the introduction of the tree. The arrival of the tree would squeeze out the import trade, for it would be easier to get the flowers from low-branched cultivated plants than tall trees in high forest.

The date of the adoption of the tree for cultivation in Java can only be guessed from the state therein of hinduized rule. We have the positive evidence of planting in Peninsular Siam in the eighth century ; with the probability that Java received it earlier.

The names indicate that there was a luxury trade in the stamens prior to the cultivation of the tree.

A NOTE ON THE PHYTOGEOGRAPHICAL RELATIONS OF SUMATRAN AND OTHER ALPINE MOSSES.

By H. N. Dixon, M.A.

In reading the discussion in the ' Proceedings ' of the Society (Sess. 1941–2, p. 148) on the biogeography of the Indo-Australian Archipelago, I was struck with a remark by Mr. H. K. Airy-Shaw, quoting van Steenis, with regard to the reversed distribution of the Sumatran plants compared with Java and Borneo, as to the lowland and alpine plants. Van Steenis states the position thus :—

' 1. The lowland plants of Sumatra, the Malay Peninsula, Borneo and the Philippines show a very close affinity, the typical representatives of which do not occur in Java and the Lesser Sunda Islands.

' 2. The mountain floras of Sumatra and Java and the Lesser Sunda Islands are closely allied with each other and must have got their elements from the Himalayan region ; it differs entirely from the Bornean mountain flora.'

Having one or two collections of alpine Sumatran mosses, I thought it would be of interest to see how far these bore out van Steenis' generalization. I have worked these out and tabulated the results, and they seem of interest ; they certainly support the statement rather markedly.

I should like to have done the same with the lowland Sumatran mosses, but, unfortunately, in the collections I have the altitudes are not given, so that it is uncertain whether the specimens are to be considered alpine or not, and I am unable to do so.

The first collection, in the following table, is one made by van Steenis himself, between 2900 m. and 3460 m. alt. The second is a small collection made on Korintji Peak, 3000–3400 m. alt., by Robinson and Boden Kloss.

Sumatran mosses	Distribution.				
	Java	Borneo	Celebes	Himalaya	Malaya
(*a*) Van Steenis collection					
Sphagnum pauciporosum Warnst.	..	+	..	..	+
S. cuspidatulum Warnst.	..	+	+	+	+
Trematodon acutus C. M.	+	..	+	..	+
Holomitrium stenobasis Dix.	..	..	+		
Dicranoloma assimile (Hpe.) Par.	+	+			
Campylopus hemitrichius (C. M.) Jaeg.	..	..	..	..	Philippines.
Funaria monticola Broth.	..	..	+		
Webera elongata (Hedw.) Schwaeg.	+	..	+	+	+
Philonotis mollis Mitt.	+	..	..	..	+
Rhacocarpus alpinus (C. H. Wright) Par.	..	+			
Distichophyllum spathulatum Doz. & M.	+				
Acanthocladium tanytrichum (Mont.) Broth.	+				
A. Hornschuchii (Doz. & Molk.) Fl.	+				
Brotherella falcata (Doz. & M.) Fl.	+	..	+		
Plagiothecium neckeroideum Bry. eur.	+	..	..	+	
Macrothamnium macrocarpum (H. & Rw.) Fl.	+	+	..	..	+
Pogonatum macrophyllum Doz. & Molk.	+				
P. microphyllum Doz. & Molk.	+				
(*b*) Robinson and Boden Kloss collection					
Dicranoloma reflexifolium (C. M.) Par.	+	..	..	..	+
D. leucophyllum (Hpe) Par. var. *Kurzii* Fl.	+	..	..	..	+
Macromitrium Blumii Nees	+	+			
Schlotheimia Grevilleana Mitt.	+	+	..	..	+
Hypnodendron Junghuhnii (C. M.) Lindb.	+	..	+	..	+
Mniodendron divaricatum (H. & Rw.)	+	..	+	..	+
Rhacopilum spectabile H. & Rw.	+	..	..	..	+
Plagiothecium neckeroideum Bry. eur.	+	..	..	+	
Oligotrichum semilamellatum (Hook.) Mitt.	+	..	..	+	

It will be seen from the above table that of the 26 species found in Sumatra, 20 occur in Java, only seven in Borneo, and eight in Celebes. Rather curiously, only one of the species found in Borneo occurs in Celebes, and only one of the Celebes species in Borneo.

Alpine mosses from New Guinea.

A rather remarkable fact has come to light recently which, while it has perhaps no direct bearing on the exact question under discussion, has some relationship to it and is of peculiar interest.

Of the above-named mosses from Sumatra and Java, only nine are known from the alpine regions of New Guinea, only one of these from Australasia. This is what we should expect from their presumed origin from the Himalayan region, through Malaya. The lowland and, to a very small extent, the alpine moss flora of New Guinea, has relations with Queensland Bryophyta, but there has been up to now no definite relation with the general bryological flora of the Australasian region, still less with the sub-antarctic section of this flora.

The recent exploration of high altitudes in New Guinea has, however, thrown an entirely new light on the situation. In his description of the mosses of the third Archbold Expedition to the Snow Mountains of Netherlands New Guinea *, Bartram has given a list of species of a very definite austral origin, with very little relation to Indo-Malayan distribution.

A tabulated arrangement will perhaps give a clearer idea of the remarkable nature of this collection. I have not included a few species of cosmopolitan distribution.

Species	Altitude in metres	Australia and Tasmania	New Zealand	Additional
Sphagnum antarcticum Mitt. ..	3400	+	+	Subantarctic
†*Blindia* (sp. nov.)	3800	+	+	Subantarctic
Dicnemon (sp. nov.)	3225	..	+	
Encalypta vulgaris Hedw.	4150		+	Holarctic
Tridontium tasmanicum Hook.f.	3800	+	+	
Orthodontium sulcatum H. f. & Wils.....	1800–2150	+	+	
Bryum truncorum Brid.	3800	+	+	Wide in southern hemisphere
Zygodon intermedius Bry. eur.	3500–3800	+	+	Asia, Africa
Z. Hookeri Hampe	3500–3800	+	+	
Polytrichadelphus (sp. nov.) ...	3400	+	+	Sub-antarctic
Dawsonia superba.....	2800	+	+	Philippines

Mr. V. S. Summerhayes has kindly made an examination of the alpine seed plants of some of the higher mountains in New Guinea, and has drawn up a list of austral genera that occur on Mt. Carstensz and the Arfak Mts., at altitudes of above approximately 1000 m. Some twenty of these genera occur on Mt. Carstensz, ten on the Arfak Mts., three being common to both. Whether the proportion of austral species in

* 'Lloydia', v, p. 245; 1942.

† In the case of new species I have given the distribution of the genus or the allied species.

these genera to that of the Malayo-Polynesian ones is similar to that which occurs in the mosses I am unable to say, but in a general way it is clear that the mosses follow the same lines as the higher plants, and indicate very clearly that in both groups the high ground of New Guinea forms the meeting place of a temperate flora from the north (Himalayan-Malayan) and another quite distinct one from the south (Australasian-Antarctic).

It is rather curious, however, that the mosses of the Archbold Expedition, from the higher altitudes, differ very markedly from those collected by Wissel on Mt. Carstensz, and the mosses of the Wollaston Expedition from the same mountain (Dixon in Journ. Linn. Soc., Bot. XLV, p. 477 ; 1922, and Dixon in ' Farlowia ', I, p. 25 ; 1943). Of the alpine genera in these two collections none show the austral relationship. This difference is perhaps fortuitous, but is certainly somewhat perplexing.

ON THE OCCURRENCE IN SUFFOLK OF A WESTERN MEDITERRANEAN CAVERNICOLOUS SPIDER, META BOURNETI SIMON (ARANEAE : ARGYOPIDAE).

By E. Browning and W. H. T. Tams,
British Museum (Natural History).

[Plate I, and a text-figure.*]

When exploring a culvert in the grounds of his home at Gedding, in Suffolk, in 1941, Lieut. R. Gibson Jarvie, R.N.V.R., found a number of examples of a large and unfamiliar spider, apparently living quite happily within the culvert. In April 1943 he sent a specimen to the British Museum (Natural History) for identification, and it proved to be *Meta bourneti* Simon.

The genus *Meta* has three other representatives in this country. Arranged in ascending size, these are as follows : *M. reticulata* Linnaeus (=*Araneus segmentatus* Clerck), *M. merianae* Scopoli, and *M. menardi* Latreille.

Meta reticulata is, perhaps, the commonest orb-weaver of our hedges and undergrowth. *M. merianae* frequents shady situations under banks and in the entrance to caves, etc. *M. menardi* is restricted to caves, cellars and hollow trees.

Meta bourneti Simon closely resembles *M. menardi* in appearance and in its selection of subterranean habitats, but it is larger in size, constructs a somewhat different egg-sac and can be distinguished by differences in the sexual organs.

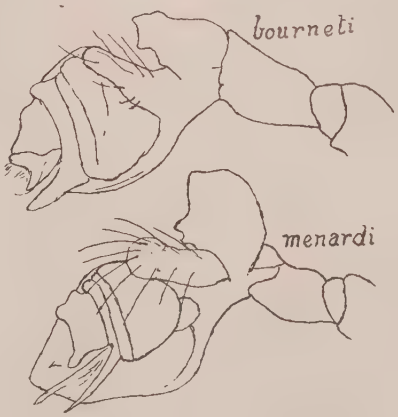
M. bourneti has been recorded from caves in France (Aude, Ariège, Ardèche, Haute-Garonne, Herault, and the Eastern Pyrenees) and Spain (Santander, de Lorca), and Algeria, Tunis and Morocco (Mont Moussa, Hadjeb). Not until 1922 was it recognized as a species distinct from *M. menardi* (E. Simon in Bull. Soc. ent. Fr. p. 199 ; 1922), so there is a possibility that records for *M. menardi* in Britain may, in some cases,

* The cost of reproducing these illustrations has been borne by the Westwood Fund.

refer to the present species. Alternatively, it may have been imported from France with wine, as is likely to have occurred frequently in the case of *Physocyclus simoni* Berl. Since the first discovery of this Pholcid in the cellars of a hotel at Bury St. Edmunds (W. S. Bristowe in Ann. Mag. Nat. Hist. ser. 10, p. 509; March 1933) it has been found in cellars in ten counties. In any event, leaving the question of the origin of *M. bourneti*, this species is definitely established at Gedding.

Through the kindness of the discoverer's mother, Mrs. R. Gibson Jarvie, the authors were invited to visit Gedding to see the spider in its haunts and to collect specimens for the Museum.

At Gedding, between Stowmarket and Bury St. Edmunds, stands a twelfth-century mansion surrounded by a moat. The surface water from the fields drains into the moat, and within the grounds some of the water is conducted to ponds through a brick-lined culvert or drain, some 40 feet long, 4 feet 6 inches high and 2 feet wide. By uncovering



Palps of male *Meta bourneti* and male *M. menardi*; after Simon.

an opening in the middle of the culvert it was possible to investigate the interior, and in spite of the cramped conditions we succeeded in exploring the whole of the drain, with most satisfactory results. The drain was reasonably dry, and a good many specimens of *M. bourneti* were found. They made no attempt to escape. At first we took only females, and then we discovered that the females were always on the walls, and that the males preferred the roof of the culvert. Three males, ten females, twelve young, and six egg-sacs were collected, but some material was left so that the colony should not be wiped out. The flourishing nature of the colony would indicate a good food supply, although we found no insects in the culvert. A number of egg-sacs were hanging from the walls and roof; these were oval in shape, made of very loosely woven whitish silk, and measured roughly 25 mm. by 22 mm. The younger spiders particularly, and some of the older ones, were found

on the orb webs, which measured from six to eight inches across. We made an attempt to collect a web, but our unsuitable equipment and the situation of the webs combined to defeat us.

The spiders were found in the two attitudes typical of the genus. In the first the two front pairs of legs were stretched forwards and the two hind pairs stretched backwards. In the second pose the legs were bent and spread evenly round the body. In looking round for other sites where this spider might be found, we discovered one young female on the wall of a nearby well, the top of which was covered with wood.

The sexes are similar in size, except that the female has a much larger abdomen.

	Female.	Male.
Length of cephalothorax	8 mm.	7 mm.
Width of cephalothorax	6 mm.	5·5 mm.
Total length of cephalothorax and abdomen	18·5 mm.	14 mm.
Width of abdomen	9 mm.	5 mm.
Length of leg I	41 mm.	41 mm.
Length of leg II	35 mm.	35 mm.
Length of leg III	25 mm.	24 mm.
Length of leg IV	33 mm.	30 mm.

A number of the young spiders have been kept alive, and have fed readily on a variety of flies. They have also accepted cockroaches and moths. All have moulted since they have been in captivity.

Meta bourneti was not previously represented in the collections of the British Museum (Natural History), and those collected have now been added.

We are indebted to Dr. W. S. Bristowe for looking over the typescript of this paper and for his suggested alterations, which we have adopted.

EXPLANATION OF PLATE 1.

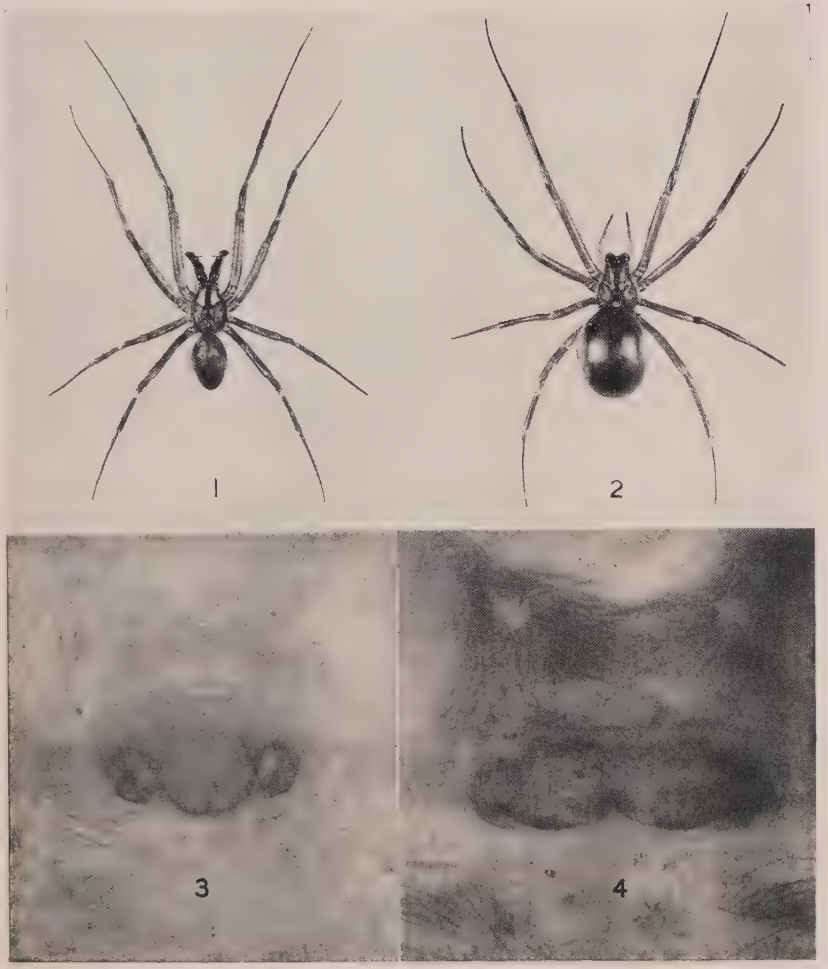
Fig. 1. *Meta bourneti* Simon, ♂, dorsal aspect. Fig. 2. *Meta bourneti* Simon, ♀, dorsal aspect. Fig. 3. *Meta menardi* Latr., ♀, epigynum × 20. Fig. 4. *Meta bourneti* Simon, ♀, epigynum × 20. Photos by W. H. T. Tams.

ON THE DISCOVERY OF NUMBERS OF MALES OF A TICK, IXODES HEXAGONUS LEACH (ACARI: IXODIDÆ).

By E. BROWNING, British Museum (Natural History), with a note on their habitat by H. K. AIRY SHAW, B.A., F.L.S., F.R.E.S.

THE rarity of the males of *Ixodes hexagonus* Leach in museum collections makes it worth while to record the recent discovery of thirteen males together with females, nymphs and larvae in a decayed elm tree near Cirencester, Glos.

There are a number of species in the genus *Ixodes* of which the males are either unknown or extremely rare in collections, probably due to the fact that ticks are usually collected from their hosts and the nests and burrows of the animals are either insufficiently searched or else are not searched at all. A further reason for the scarcity of males may be that males have a shorter life than females.



[*Photos by W. H. T. Tams.*

META BOURNETI SIMON AND META MENARDI LATR.

The male of *I. hexagonus* has only once been found on a host, a badger (Walton, 1918). Only one other male has been found in this country; it was taken from a hedgehog's nest at Cambridge (Nuttall, 1911). Professor Nuttall obtained a male from Professor Neumann, taken in the Forêt de la Londe, Seine Inférieure. Both of the last two quoted specimens, being part of the Nuttall Collection, have now been added to the collections of the British Museum (Natural History). Previous to this there were no males in the collections of the British Museum (Natural History), nor were there any in the museums of Paris or Berlin.

I. hexagonus is a common tick of various hosts, more especially the hedgehog, stoat, and ferret; it has been taken from man and also cat, dog, fox, polecat, otter, badger, cattle, sheep, squirrel, mink, sable, beech marten, pine marten, hare, rabbit, marmot, opossum, porcupine, wolf, house and tree sparrow, corncrake, and golden plover.

It is widely distributed in Great Britain and Ireland, and is also recorded from the following countries:—Belgium, France, Germany, Italy, Portugal, Serbia, Switzerland, Algeria, and several North American States.

Thirteen males, eighteen females, seventy-two nymphs and sixteen larvae were collected from small galleries in a piece of the decayed elm at Cirencester.

According to Dr. H. E. Hinton, the weevil, *Cossonus parallelopipedus*, was found in small numbers in some of the numerous galleries in the decayed piece of elm, but it is not certain whether this species was responsible for making the galleries. A few cast larval skins of the Elaterid *Melanotus rufipes* were also found in the wood. The larvae of this species are predacious, and were possibly preying on the larvae and pupae of the weevil. The large holes may have been made by a Cerambycid, but it was not possible to identify them with certainty.

Except for a few specimens of woodlice, *Philoscia muscorum* Scopoli and *Porcellio ratzeburgii* Brandt, and four young spiders, *Harpactes hombergii* Scopoli and *Segestria senoculata* Linnaeus (fam. Dysderidae), no other animal life was represented.

The ticks made no attempt to move when exposed to light when the wood was broken up, but when disturbed with a probe they retreated into the cracks of the wood. When placed in a small dish, they walked around as if seeking for a place to hide. All stages were flattened, with no appearance of blood in them, as if they had not fed for some time, and all the females, nymphs and larvae were totally undistended.

The number of thirteen males and eighteen females which were collected shows a very remarkable sex ratio and represents a very high proportion of males to females.

I. hexagonus is adequately figured and described in Nuttall (1911).

Our knowledge of the biology of *I. hexagonus* is confined to a paper by Nuttall (1913) in which he records the observations that were made, and the following summary is given by him:—

'Attempts to raise *Ixodes hexagonus* upon their natural hosts in captivity have hitherto failed. From what we have observed we know that the tick requires three hosts upon which to feed, in the larval, nymphal and adult stages respectively. There is no evidence that the

male ever sucks blood. Oviposition takes place in 8 to 14 days after the female abandons the host in the spring, and the process lasts 32 days at 9·5° C.; the female may survive about a week after oviposition has ended. The female may lay 250 to 650 eggs, a comparatively small number, the tick being usually found on burrowing animals. The time required for metamorphosis from egg to the larval stage varied between 73 and 102 days, and the corresponding period for the change from nymph to adult was 77 days at 13–18·5° C., when confined in a pill-box. Unfed larvae survived at least three months.

'*Larva to nymph.* No observations recorded, as repeated efforts to raise these and other lots of larvae on hedgehogs and other ordinary hosts failed.'

The penetration beneath the skin by this tick and the forming of a cyst on a fox is described by Nuttall (1914) and Walton (1918). It is not due to the mechanical activity of the tick but to increasing oedema and inflammatory swelling of the host's skin, the surface of which rises above the subjacent tissues in which the tick's hypostome is anchored.

I. hexagonus has been accused of transmitting canine piroplasmosis (Alessandrini, 1917).

Mr. H. K. Airy Shaw discovered the ticks and has supplied the following notes on their habitat :—

'For several years past I have been interested in the distribution of the local Midland elm, *Ulmus Plotii* Druce, and the frequency of this species in the Cirencester district of Gloucestershire attracted my attention as soon as I came to live here in 1940. Hence it was not long before I noticed a truncated and moribund specimen standing by the roadside just inside the low stone wall of a school playing-field about 200 yards from my mother's house in the Somerford Road. This locality lies in the suburb of Chesterton, about one mile due south of the centre of Cirencester, at an altitude of just over 400 feet (120 m.). The geological formation of the area is Forest Marble—alternating layers of grey clay and hard, fissile limestone, forming poor, wet, sticky soils, mostly under grass—overlaying the Great Oolite.

'The decapitated trunk of the tree is now about thirty feet (9 m.) in height, with one small branch, half-way up, which is still quite vigorous, while a number of sturdy suckers (two already twenty to twenty-five feet high) have been thrown up along the line of the wall, and will, one hopes, be allowed to perpetuate the species. At the base of the trunk, which is nine to ten feet in circumference, there is a gash about three feet long, above which the bark has been stripped off the trunk almost to the top. This gash, which faces almost south, has exposed the inner wood, now quite soft and pulpy, right down to the ground level.

'On Christmas Day, 1943, I was examining the tree for Coleoptera, breaking off pieces of loose bark and pulling out pieces of pulpy wood from the aperture at the base. I found no beetles whatever, but upon breaking up the pulpy wood I was surprised to find a number of ticks (subsequently identified by Mr. E. Browning as *Ixodes hexagonus* Leach) concealed in the crevices and old beetle-galleries. No other form of life was seen except some spiders and woodlice. It was only the fact that

this seemed to me to be an unusual habitat for parasites such as ticks that led me to communicate with the British Museum on the subject—with the fortunate result now recorded. In response to Mr. Browning's request, a further visit was paid to the tree on 20 January, when many more specimens were taken, but no attempt was made to exhaust the habitat in respect of the ticks. A piece of the pulpy wood was also sent to the Museum so that the ticks could be seen *in situ*.

'I saw no evidence of the tree having been used by any animal for nesting purposes. Hedgehogs, dogs and occasional foxes would seem to be the most likely visitors. A *cache* of moribund lepidopterous larvae was found under part of the loose bark, four to five feet up, on 25 December, together with a single dead specimen of the Pentatomid bug *Acanthosoma haemorrhoidale* L., but these were perhaps the work of spiders, or of the nuthatch (*Sitta*) or tree-creeper (*Certhia*).

'The particulars of the habitat have been given in some detail, since, with so little knowledge of the habits and life-histories of these creatures, it is difficult to be certain as to what is relevant and what is not. The botanical details given above are not, however, to be taken as implying any suggestion that these ticks deliberately chose *Ulmus Plotii* in preference to the more commonplace *U. procera* (and *Tilia vulgaris*) growing nearby.'

These specimens of *Ixodes hexagonus* (with the exception of four females) have been added to the collection of the British Museum (Natural History).

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JONAS DRYANDER (1748–1810).

By Dr. Arvid H. Uggla.

Jonas Carlsson Dryander, b. 5 March 1748 in Göteborg, d. 19 Oct. 1810; buried in St. Anne's Church, Soho, London. Father: Carl Leonard Dryander, teacher at the Public School, Göteborg. Mother: Brita Maria, *née* Montin. Entered the Latin Grammar School ('Trivialskolan'), Göteborg, 27 Aug. 1759. Undergraduate at Upsala University 4 Sept. 1765; defended a thesis 'pro exercitio' 12 Oct. 1768; matriculated at Lund University 11 Nov. 1776; Cand. philos. 18 Dec. same year; defended a thesis 'pro gradu philosophico' same year; M.A. ('absens') 23 June 1778; went to England in the summer of 1777; was engaged by Sir Joseph Banks, from 1782, as his Librarian; Librarian to the Royal Society from 1785; one of the founders of the Linnean Society, 1788: its honorary Librarian same year and one of its vice-presidents from 1794 until his death. Member of the Swedish Academy of Sciences 1784; 'associé' to the Société d'histoire naturelle of Paris 1790. Unmarried.

In 1757, when nine years of age, Dryander lost his father. His mother afterwards married Gudm. Djurberg, rector of the town of Halmstad. In his uncle, Lars Montin, physician to the province of Halland, himself an outstanding botanist and a pupil of Linnaeus, he found a fatherly friend.

At Upsala, Dryander defended in 1768, ' pro exercitio ', a part of Johan Ihre's ' Analecta Ulphilana ', together with some ' theses '. King Gustavus III was present at this ' disputation '. It is reasonable to suppose that, under the influence of his uncle, young Dryander should be attracted to the study of Natural History ; and it is not impossible that, when at Upsala, he may have heard some of Linnaeus's lectures. Very early he was an intimate friend of C. P. Thunberg. In the autumn of 1772 he was a private tutor in the house of Baron M. W. Lejonsköld, at Hornö in the province of Upland, later at Ryda near the town of Enköping, where G. W. af Sillén, Councillor, a cousin of his mother, lived. This tutorship became ' academic ' in the spring—that is, he was allowed to follow his pupils to the University and consequently could continue his own studies. In the autumn of 1776 he went to the University of Lund, and there very soon passed his examinations and presented his doctoral thesis, which was defended under the ' praesidium ' of Prof. E. G. Lidbeck. It treated of a subject then very much discussed—the nature of Fungi ; its starting-point being a theory put forward by Baron Münchhausen, the well-known Chancellor of the University of Göttingen, that Fungi were animals, not plants. This conception Dryander tried to refute. In a letter to Thunberg, written about this time, he mentions his intention of going to England next spring with the help of a scholarship, and to stay there as long as his means would allow. He arrived in England on 10 July 1777. This journey decided his future life. It seems that he was at once introduced to Sir Joseph Banks by Daniel Solander, Banks's friend and associate. During the following year he became a botanical assistant to Banks, and early in 1779 he introduced Thunberg to Banks and his friends. When, in 1781, the younger Linnaeus arrived in London, Dryander mentions him, but in a rather critical way. In some of the younger Linnaeus's letters to Swedes one gets a glimpse of Dryander fetching the books needed when Banks, Solander and the younger Linnaeus were busy with new plants.

During the younger Linnaeus's stay in London, Solander died on 12 March 1782, and Dryander's position at Sir Joseph's house became a more important one. He remained as a member of Sir Joseph's scientific staff until his own death, and in particular was entrusted with his collections. Through his presidency of the Royal Society (from 1778), through his wealth and travels, Sir Joseph's position in the scientific world was an extraordinary one, and his magnificent house in Soho Square became the meeting-place of all who were prominent in science. From the poor remains of Dryander's correspondence that have been preserved, it appears that very often he became the medium through which foreign travellers were granted an invitation to visit the rich collections. When collections were purchased, e.g. Clifford's herbarium, he was Banks's councillor and agent ; and especially he aimed at completing the library. As Sir Joseph's librarian his rôle became very important. His friend Robert Brown, the famous botanist, in his writings explicitly acknowledges the value of his help ' both as to the formation of genera and respecting synonyms, on which points his sound judgement and unrivalled erudition so well enable him to decide '.

Dryander's foremost contribution was the catalogue of Sir Joseph's library, compiled with exemplary accuracy and published in five volumes from 1798 to 1800. As early as 1785 he reported being busy with this work, and stated that he hoped to be able to print it 'next winter'. Meanwhile, he endeavoured to complete the library, and to that end issued printed lists of desiderata. When published, the catalogue was conspicuous for its extraordinary completeness. Dryander has systematized the literature to a degree * which may seem excessive, but it must have needed uncommon knowledge and wide experience to have accomplished it. In his obituary his friend J. E. Smith says that 'no other science possesses anything similar'. In his preface to the well-known work, 'Thesaurus literaturae botanicae' (1851), G. A. Pritzel pronounced: 'After Séguier, Linnaeus and Haller, who published important works during the preceding century, the only author worth mentioning is the eternally memorable author of the Bibliotheca Banksiana, Jonas Dryander. But his work, which is in all respects superior to all other books about botanical literature, is so scarce, that even the public libraries are not able to obtain a copy.' (The edition is said to have been only 250 copies.)

Dryander's botanical contributions were in the main incorporated in the work 'Hortus Kewensis', which was published under W. Aiton's name. The first edition of that catalogue of the plants cultivated in Kew Gardens appeared in three volumes in 1789. It had been corrected in proof-sheets by Dryander and the descriptions of many of the new plants, here published for the first time, must have originated from him (or from Solander), Aiton being more gardener than botanist. It has also been pointed out that those plants ought to have been quoted with Dryander instead of Aiton as author; although Dryander, as a result of his work in the Banksian herbarium, also has utilized the descriptions of other botanists, e.g. Solander, and even the younger Linnaeus. (In the later edition, 1810–12, Willdenow's name was put in as author instead of the younger Linnaeus.) With this edition (the two first volumes) Dryander was busy until his death, as appears from the younger Aiton's acknowledgement.

Dryander was also librarian to the Royal Society from 1785, with an annual remuneration of £20. It has also been affirmed that he was appointed to the British Museum after Solander's death, but this appears to be incorrect. The assertion that he received the M.D. degree from Oxford University seems also to be without foundation.

Dryander had an important part in the foundation of the Linnean Society in 1788, and in the consolidation of its position. He is named in the first Charter, was elected honorary librarian, and later, in 1794, one of the vice-presidents. As, after his removal to Norwich in 1796, James Edward Smith was unable, except once or twice each session, to preside over the Meetings, Dryander most frequently took the Chair. When the Society was obtaining the Royal Charter of 1802, he drew up the Statutes of the Society to be submitted to the King. To the 'Transactions' of the Society he made several contributions.

* [in the Botany section there are 833 subdivisions.]

Following his election in 1784, as a member of the Swedish Academy of Science, he presented to the Academy the rich herbarium, which, at his uncle, Lars Montin's, death in 1785, had been bequeathed to him. It contained a number of plants received from Linnaeus.

Dryander remained a bachelor. In a letter to Thunberg he confided with him about proposing to a young lady, Miss Hamilton, whose mother let rooms to him near Sir Joseph Banks's house in Soho Square. However, he gave up the idea of marrying.

At the time of his death he was lodging with a certain Galazzi, evidently one of the numerous Italians living in that quarter. He was buried in St. Anne's Church, Soho.

Dryander became a quiet, dignified old gentleman, who conscientiously attended to his duties, without troubling much if others were credited with the results. To Pehr Afzelius, who in 1785 was introduced to Sir Joseph by him, he seemed 'well read, but somewhat magniloquent. He boasts of his membership of the Swedish Academy of Science'. He had very few wants. When he died, his friend Robert Brown took care of his very poor effects. It is told, as a proof of his few requirements, that when Sir Joseph once offered to add to his salary, he firmly declined : he had enough for his needs. From his probably very extensive correspondence little more than one, rather insignificant, packet of letters has been preserved. This was sold with the Banksian MSS., but is now in the British Museum (Natural History). Thunberg had given a Japanese plant his friend's name, but it being found that this ought to be reduced to another genus, Robert Brown dedicated to him the genus of Proteaceae which still bears the name *Dryandra*. It was selected because of its affinity to *Banksia*, which was named after their common friend and patron.

CONTRIBUTIONS TOWARDS THE FUNGUS FLORA OF UGANDA.—VI. NEW RECORDS.

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1. Phytophthora infestans De Bary in Journ. Roy. Agric. Soc., England, II, xii, p. 239 (1876). On cultivated *Solanum tuberosum*, Kabale, Kigesi, November 1942 ; Toro, April 1943, *Hansford*.

2. Syncephalastrum racemosum (Cohn) Schroeter in Krypt. Flor. Schles., Pilze, i, p. 217 (1885). On seed of *Saccharum officinarum* from Barbados, germinating in laboratory, Kawanda, Uganda, *Hansford*, det. *G. R. Bisby*.

3. **MASONIA** Hansford, gen. nov. Myriangiacearum. Fungi in foliis parasitici ; hyphae externae dilute olivaceae, septatae, exhyphopodiatae ; hyphae intramatricales hyalinae, inter cellulas mesophylli per stomata penetrantes ; haustoria nulla. *Ascomata* atrobrunnea superficialia, subglobosa vel lobata, setosa, in hyphis mycelii superficialis evoluta,

subastoma ; loculi subglobosi, monascigeri ; paries loculi tenuiter parenchymaticus, olivaceus. *Asci* subglobosi, aparaphysati, 8-spori. *Sporae* atrobrunneae, muriformes.

Masonia Chlorophorae Hansford, sp. n. *Plagulae* hypophyllae, effusae, dilute brunneae, tenues, in tomento folii latentes. *Mycelium* superficiale ex hyphis dilute olivaceis 2–3 μ crassis exhyphopodiatis flexuosis septatis (cellulis 10–30 μ longis) ad septa haud constrictis irregulariter ramosis laxe reticulatis et saepe anastomosantibus inter pilos folii compositum. *Hyphae intramatricales* per stomata introientes et inter cellulas mesophylli inferioris penetrantes, hyalinae, 1–2 μ crassae, obscure septatae, irregulariter ramosae. *Haustoria* nulla. *Ascomata* superficialia, irregulariter globosa et saepius 2—4-lobata, atro-olivacea, 80–150 μ diam. et circa 50 μ alt., ubique dense setosa, inter pilos folii laxe dispersa. *Setae* olivaceae, cylindraceae, flexuosae vel circinatae et intertextae, obscure septatae, 1·5–2 μ crassae, simplices, obtusae, usque ad 60 μ longae. *Paries loculorum* parenchymaticus, 4–5 μ crassus, ex strato uno cellularum angulosarum 3–4 μ diam. et strato uno interiore indistincto compositus, extus dilute olivaceus. *Asci* singuli in loculis dispositi, aparaphysati, subglobosi, sessiles, 8-spori, 40–45 μ diam. *Sporae* conglobatae, atrobrunneae, oblongae, utrinque rotundatae, leves, transverse 6—8-septatae et longitudinaliter 1–2-septatae, in medio leniter constrictae, 30–34 × 13–16 μ.

Hab. in foliis *Chlorophorae excelsae*, Entebbe Road, Uganda, *Hansford 3147*.

The fungus causes pale brownish to yellowish effuse areas on the lower surface of the leaf, not visible from above and hidden in the dense tomentum, the colour being due to the numerous dark ascomata scattered over the leaf surface among the leaf hairs. External mycelium of pale olive-brown hyphae 2–3 μ thick, exhyphopodiate, flexuous, septate, the cells 10–30 μ long, not constricted at the septa, loosely reticulate over the leaf among the leaf-hairs, frequently anastomosing by lateral processes and with branches entering the stomata. In the lower mesophyll a branched hyaline mycelium penetrates the intercellular spaces, not forming haustoria, the hyphae 1–2 μ wide, indistinctly septate, irregularly ramose. The ascomata are formed on the external mycelium, commencing as dark knots of parenchyma about 20 μ diam., which enlarge and usually become lobed, each lobe representing a loculus containing a single ascus. Occasional ascomata are simple, 1-locular and having only one ascus. The larger ascomata are 2—4-locular, irregularly globose to pulvinate, the lobes slightly divergent above and connected laterally by a very thin tissue of similar structure to the loculus wall ; over the whole sides and upper part the ascomata are clothed with numerous flexuous to circinate and interwoven setae, simple, dark to pale olivaceous, obtuse, indistinctly septate, up to 60 × 1·5–2 μ. Beneath these setae the wall of the ascoma consists of an olivaceous layer of angular parenchymatous cells 3–4 μ diam. and enclosing an indistinct inner layer of small, much compressed, hyaline parenchyma ; the whole wall 4–5 μ thick. Each of the locular lobes is slightly attenuate, rounded at the apex, with an irregular apical pore not well differentiated, becoming widely open at full maturity. At first the loculus wall encloses a hyaline parenchymatous nucleus in

which the single ascus develops from the base ; mature asci aparaphysate, filling the whole loculus, more or less globose, with thin wall, sessile, 8-spored, 40–45 μ diam. Spores at first hyaline, finally subopaque dark brown, conglobate, oblong, with widely rounded ends, muriform, smooth, with 6–8 trasnverse and 1–2 longitudinal septa, 30–34 $\times$ 13–16 μ, sometimes slightly constricted at the middle septum and with the upper half very slightly wider than the lower.

The systematic position is somewhat doubtful, as the typical fleshy structure of Myriangiaceae is absent, but the type of spore and the single large asci indicate this family rather than Sphaeriaceae.

4. Parenglerula Macowaniana (Thüm.) v. Höhnel in Fragm. z. Mykol., x, no. 525 (1910). On *Gymnosporia* sp., Entebbe Road, Uganda, *Hansford 2792.*

5. **Irenina Antidesmae** Hansford, sp. n. *Plagulae* amphigenae, saepius epiphyllae, orbiculares, tenues, atrae, usque ad 5 mm. diam. *Mycelium* ex hyphis atrobrunneis subrectis vel sinuosis 7–9 μ crassis septatis (cellulis 20–30 μ longis) irregulariter ramosis et laxe reticulatis compositum. *Hyphopodia capitata* alternata vel unilateralia, antrorsa, 25–33 μ longa ; cellula basalis cuneata vel cylindracea, recta vel antrorse curvata, 8–13 μ longa ; cellula apicalis clavata, irregulariter 3—5-lobata, 14–23 $\times$ 15–23 μ. *Hyphopodia mucronata* numerosa, opposita, ampullacea, collo longo curvato praedita, saepe in hyphis distinctis evoluta. *Setae myceliales* nullae. *Perithecia* dispersa, atra, globosa verrucosa, usque ad 180 μ diam., cellulis parietis conicis. *Asci* bispori, evanescentes. *Sporae* atrobrunneae, cylindraceae, utrinque rotundatae, 4-septatae, constrictae, 40–47 $\times$ 16–18 μ.

Hab. in foliis *Antidesmae venosi*, Entebbe Road, Uganda, *Hansford 3180*, 2407.

In a previous account of this group of fungi in Uganda, the present species was included in *Irenina glabra* (Berk. & Curt.) Stev., but the colonies are larger, thinner and rather different in macroscopic appearance ; the hyphopodia are more regularly alternating and directed forwards at about 45°. The Beeli formula is 3101.4220.

6. **Irenina Caseariae** Hansford, sp. n. (*2101. 4230.*) *Plagulae* epiphyllae atrae, orbiculares, tenues, leves, usque ad 4 mm. diam. *Mycelium* ex hyphis subrectis radiantibus 6–7 μ crassis atrobrunneis septatis (cellulis 25–35 μ longis) irregulariter ramosis et laxe reticulatis compositum. *Hyphopodia capitata* alternata vel unilateralia, antrorsa, 23–30 μ longa, cellula basalis cylindracea, 6–12 μ longa ; cellula apicalis irregulariter tenuiter 2–3-lobata, 14–19 $\times$ 15–18 μ. *Hyphopodia mucronata* dispersa, haud numerosa, lageniformia. *Setae myceliales* nullae. *Perithecia* dispersa, globosa, atra, verrucosa, usque ad 240 μ diam., cellulis mammillatis. *Asci* bispori evanescentes. *Sporae* atrobrunneae, cylindraceae, utrinque rotundatae, saepe leniter curvatae, 3-septatae, leniter constrictae, 42–49 $\times$ 16–18 μ.

Hab. in foliis *Caseariae Engleri*, Entebbe Road, *Hansford 3181 p.p.*

7. Irenina glabroides Stev. in Ann. Mycol., xxv, p. 463 (1927). On leaves of *Entandrophragma* sp., Kiterera, Busoga, *Hansford 2830.*

8. Irenina manca (Ell. & Mart.) Stev., loc. cit., p. 448 (1927). On leaves of *Myrica* sp., Bombo Road, Uganda, *Hansford 2704.*

9. Irenina mangostana (Sacc.) Stev., loc. cit., p. 457 (1927). On

Symphonia gabunensis, Lake Nabugabo, Masaka, Uganda, *Hansford 2581* (ex *P. Chandler 1951* in Herb. Bot. Uganda).

10. **Irenina Syzygii** Hansford, sp. n. (*3101.4220.*) *Plagulae* amphigenae, tenues, atrae, leves, usque ad 3 mm. diam. *Mycelium* ex hyphis atrobrunneis sinuosissimis vel tortuosis 5–6 μ crassis septatis (cellulis circa 20 μ longis) saepius opposite ramosis et laxe reticulatis compositum. *Hyphopodia capitata* alternata vel unilateralia, 15–20 μ longa, antrorsa, erecta vel retrorsa ; cellula basalis cylindracea, recta vel curvula, 3–7 μ longa ; cellula apicalis clavata vel cylindracea, sursum rotundata, integra, 11–13 × 7–9 μ. *Hyphopodia mucronata* pauca ampullacea. *Setae myceliales* nullae. *Perithecia* dispersa, globosa, atra verrucosa, usque ad 180 μ diam., cellulis conicis usque ad 25 μ longis. *Sporae* atrobrunneae, cylindraceae, utrinque rotaundate, 4-septatae leniter constrictae, 44–48 × 17–20 μ.

Hab. in foliis *Syzygii cordati*, Entebbe Road, Uganda, *Hansford 3179 p.p.*

11. Irenina Tremae (Speg.) Stev. in Ann. Mycol., xxv, p. 457 (1927). On leaves of *Trema guineensis*, Rifle Range, Kiagwe, Uganda, *Hansford 2571, 2700.*

12. Meliola Alchorneae Stev. & Tehon in Mycologia, xviii, p. 12 (1926). On leaves of *Croton macrostachys*, Entebbe Road, Uganda, *Hansford 3022.*

13. **Meliola Argomuellerae** Hansford, sp. n. (*3111.4322.*) *Plagulae* amphigenae, orbiculares, atrae, tenues, usque ad 5 mm. diam., raro in confluendo majores. *Mycelium* ex hyphis atrobrunneis subrectis radiantibus 6–8 μ crassis septatis (cellulis plerumque 25–40 μ longis) saepius opposite ramosis laxe reticulatis compositum. *Hyphopodia capitata* alternata vel unilateralia, clavata, recta vel curvula, 15–23 μ longa ; cellula basalis cylindracea, 3–6 μ longa ; cellula apicalis cylindracea vel clavata, integra, sursum rotundata, 13–18 × 9–12 μ. *Hyphopodia mucronata* disperas, opposita vel unilateralia, pauci, longe ampullacea. *Setae myceliales* dispersae vel circum perithecia aggregatae, erectae, rectae, atrae, simplices usque ad 320 × 7–8 μ, apice attenuatae vel subacutae. *Perithecia* dispersa, globosa, atra, verrucosa, usque ad 160 μ diam., disco hypharum exhyphopodiatarum insidentia. *Asci* bispori, evanescentes. *Sporae* atrobrunneae, oblongae utrinque rotundatae vel subellipsoideae, rectae vel curvulae, 4-septatae, constrictae, 42–47 × 16–21 μ.

Hab. in foliis *Argomuellerae macrophyllae*, Kawanda, Kampala, Uganda, *Hansford 3175.*

14. Meliola Arundinis Pat. in Journ. de Bot., xi, p. 348 (1897). On *Phragmites mauritianus*, Entebbe Road, Uganda, *Hansford 3146.*

15. **Meliola entebbeensis** Hansford, sp. n. (*3121.5332.*) *Plagulae* amphigenae, atrae, velutinae, densae orbiculares vel irregulares, usque ad 12 mm. diam., in confluendo multo majores. *Mycelium* ex hyphis atrobrunneis subrectis vel leniter sinuosis 8–9 μ crassis septatis (cellulis 25–40 μ longis) opposite vel irregulariter ramosis dense reticulatis compositum. *Hyphopodia capitata* alternata vel unilateralia, 30–40 μ longa, recta vel curvula, erecta vel antrorsa ; cellula basalis cylindracea, 12–21 μ longa ; cellula apicalis irregulariter 2—5-lobata, 18–25 × 17–20 μ. *Hyphopodia mucronata* dispersa ampullacea. *Setae myceliales* numerosae,

dispersae, simplices, obtusae, usque ad 360×8–10 μ, irregulariter flexuosae vel distincte lateque hamatae. *Perithecia* dispersa, globosa, atra, verrucosa, usque ad 220 μ diam. *Asci* bispori, evanescentes. *Sporae* atrobrunneae, cylindraceae utrinque rotundatae, vel subellipsoideae, 4-septatae constrictae 48–56×18–21 μ.

Hab. in foliis *Aristolochiae dorsiveniae*, Entebbe Road, *Hansford 3178*.

The setae are very rarely straight and erect, but are usually widely hamate, with the apices recurved downwards ; this is seen in the fresh material and is not an effect of drying and pressing.

16. Meliola Merrillii Syd. in Philipp. Journ. Sci., viii, p. 479 (1913). On *Rhoicissus Revoillii*, Entebbe Road, Uganda, *Hansford 2787* ; Kiterera, Busoga, Uganda, *Hansford 2812*.

17. Meliola Panici Earle in Muhlenbergia, 1901, p. 12. On *Trichopteryx* sp., *Hoima*, Uganda, *Hansford 2659*.

18. Meliola reflexa Hansford in Proc. Linn. Soc. Lond., Sess. 153, p. 11 (1941). Further collections of this species have shown that the distinction from *M. Funtumiae* Beeli var. *hamata* Hansf. & Stev. (in Journ. Linn. Soc. Lond., li, p. 274 ; 1937) cannot be maintained as the two intergrade. The difference from *M. Funtumiae* is sufficient to render it a distinct species, and as the specific name *hamata* has been used by Sydow for a different species, the present one must be known as *M. reflexa* Hansf.

19. **Meliola Secamonis** Hansford, sp. n. (*3111.4221.*) *Plagulae* amphigenae, densae, atrae, subcrustosae, orbiculares, velutinae, usque ad 3 mm. diam., dispersae. *Mycelium* ex hyphis atrobrunneis sinuosis 6–9 μ crassis septatis (cellulis 12–25 μ longis) saepius opposite ramosis dense reticulatis compositum. *Hyphopodia capitata* alternata, antrorsa, 17–25 μ longa ; cellula basalis cylindracea vel cuneata 3–8 μ longa ; cellula apicalis ovata vel subglobosa, integra 12–18×10–13 μ. *Hyphopodia mucronata* pauca, dispersa, ampullacea, opposita vel unilateralia. *Setae myceliales* numerosae, erectae, rectae, simplices, acutae, usque ad 250×8–9 μ. *Perithecia* in centro plagularum aggregata, globosa, verrucosa atra, usque ad 200 μ diam. *Sporae* cylindraceae utrinque rotundatae, atrobrunneae, 4-septatae, constrictae, 40–45×15–17 μ.

Hab. in follis *Secamonis platystigmatis*, Entebbe Road, Uganda, Hansford 3189.

This differs from *M. Strophanthi* Hansf. chiefly in the shorter setae and rare mucronate hyphopodia.

20. **Meliola Sersalisiae** Hansford, sp. n. (*3113.4221.*) *Plagulae* epiphyllae, atrae, densae orbiculares, usque ad 3 mm. diam. *Mycelium* ex hyphis atrobrunneis subrectis 6–8 μ crassis septatis (cellulis saepius 20–30 μ longis) opposite ramosis dense reticulatis compositum. *Hyphopodia capitata* plerumque opposita, etiam alternata vel unilateralia, antrorsa, 13–18 μ longa ; cellula basalis cylindracea, 2–5 μ longa ; cellula apicalis clavata vel ovata, integra, 10–14×7–9 μ. *Hyphopodia mucronata* dispersa, opposita, ampullacea. *Setae myceliales* praecipue juxta perithecia evolutae, haud numerosae, erectae, rectae, simplices, obtusae, usque ad 250×8–10 μ. *Perithecia* dispersa, globosa, atra, verrucosa, usque ad 180 μ diam., disco hypharum exhyphopodiatarum insidentia. *Sporae* oblongae vel subellipsoideae, utrinque rotundatae, atrobrunneae, 4-septatae, constrictae 37–43×14–16 μ.

Hab. in foliis *Sersalisiae* spec., Entebbe Road, Uganda, *Hansford 3186 p.p.*

21. Meliola Soroceae Speg. in Anal. Mus. Nac. Buenos Aires, xxiii, p. 1343 (1912). On *Bosquiea Phoberos*, Entebbe Road, *Hansford 2912, etc.*

22. **Meliola Turraeae** Hansford, sp. n. (*3133.4221.*) *Plagulae* epiphyllae, atrae, orbiculares, dispersae, usque ad 4 mm. diam., tenues. *Mycelium* ex hyphis atrobrunneis subrectis vel flexuosis 6–7 μ crassis septatis (cellulis 25–30 μ longis) opposite ramosis laxe reticulatis compositum. *Hyphopodia capitata* opposita vel alternata, 12–16 μ longa, recta, antrorsa vel erecta ; cellula basalis cylindracea, 3–5 μ longa ; cellula apicalis clavata, sursum rotundata, integra 10–12 × 8–10 μ. *Hyphopodia mucronata* opposita, dispersa, lageniformia. *Setae myceliales* numerosae, dispersae, erectae, rectae, usque ad 240 × 7–9 μ, apice 3—6-dentatae (— 10 μ) cristatae. *Perithecia* dispersa, globosa, atra, verrucosa, usque ad 170 μ diam. *Asci* bispori, evanescentes. *Sporae* atrobrunneae, oblongae, utrinque rotundatae, 4-septatae, leniter constrictae, 41–47 × 14–17 μ.

Hab. in foliis *Turraeae floribundae*, Entebbe Road, Uganda, *Hansford 3174 p.p.*

23. **Dimerium africanum** Hansford. The type from South Africa has been described in a paper now in the press. The following specimen, on *Meliola Teclea* Hansf. on *Teclea nobilis*, Entebbe Road, Uganda, *Hansford 3194 p.p.*, differs somewhat from the South African specimens and from others found in Uganda, especially in the size of the spores :—

Mycelium of subhyaline to very pale olivaceous hyphae 2–3 μ wide, indistinctly septate, closely covering the *Meliola* hyphae and forming almost a solid plate between them, the mycelium appearing almost white to the naked eye. Perithecia closely scattered, dark brown, not black, 80–130 μ diam., globose, smooth, with apical pore 20–40 μ diam. ; wall of a single layer of reddish-brown angular parenchyma 6–10 μ diam., 3–5 μ thick, enclosing an indistinct layer of flattened hyaline parenchyma ; around the apical pore the wall cells are very slightly papillate and slightly paler. Asci numerous, basal fasciculate, when young with numerous filiform hyaline paraphyses which disappear at maturity, cylindric, rounded at the apex, scarcely thickened, subsessile or very shortly nodose-pedicellate, 8-spored, about 70 μ long by 12–16 μ diam. when mature. Spores 2-seriate, reddish brown, oblong with rounded ends, smooth, 1-septate, slightly constricted, 15–19 × 6–7 μ, the cells more or less equal or the upper very slightly wider than the lower.

24. **PHAEOPHRAGMERIELLA** Hansford, gen. n. Fungi in myceliis fungorum aliorum parasitici ; hyphae superficiales, olivaceae, ramosae, septatae, exhyphopodiatae ; setae myceliales nullae. Perithecia dispersa, superficialia, atrobrunnea, globosa vel ovata, indistincte ostiolata, perforata, mollia, parenchymatica, extus setis vel hyphis brevibus plus minusve vestita, Asci clavato-cylindracei vel saccati, 8-spori, aparaphysati. Sporae clavulatae, fusoideae vel elongatae olivaceae, transverse multiseptatae.

Type species : *P. meliolicola* (Syd.) Hansford, comb. n,

Syn. *Chaetosphaeria meliolicola* Syd. in Ann. Myc., xii, p. 555, 1914.

Phaeophragmeriella Stegasphaeriae Hansford, sp. n. *Perithecia* singulariter dispersa vel laxe 2—3-aggregata, superficialia, subopace atrobrunnea, globosa, circa 150 μ diam., sursum setis numerosis radiantibus erectis vel depressis olivaceis rectis vel flexuosis simplicibus obtusis obscure septatis circa 50 $\times$ 4–5 μ ornata, vel setis reflexis et in hyphis mycelii transeuntibus. *Paries perithecii* membranaceus, circa 8 μ crassus, parenchymaticus, atrobrunneus, 2—3-stratosus, cellulis 5–10 $\times$ 4–6 μ, strato interiore hyalino fibroso, poro apicali rotundato 20–25 μ diam. periphysato pertusus. *Asci* numerosi, basales, fasciculati, cylindracei, sursum rotundati, haud incrassati, subsessiles, 70–90 $\times$ 10–13 μ; paraphyses numerosae, filiformes, simplices, hyalinae, 1–2 μ crassae. *Sporae* 8, oblique 1-seriatae, hyalinae, in maturitate dilute olivaceae, fusoideae, utrinque rotundatae, leves, 3-septatae, leniter constrictae, 23–27 $\times$ 5–6 μ.

Hab. in ostiolis *Stegasphaeriae ugandensis* in foliis *Macarangae Pynaertii*, Entebbe Road, Uganda, *Hansford 3165*.

The fungus is parasitic on the ostioles of the *Stegasphaeria* and its mycelium penetrates into the perithecia of its host, consisting of pale olivaceous to subhyaline exhyphopodiate hyphae 1·5–3 μ wide, indistinctly septate, irregularly branched, emerging from the host perithecia and extending outwards over the leaf-surface. The perithecia are scattered or in loose groups of 2–3 on the external mycelium, usually on or close to the ostioles of the host, and bearing numerous erect or reflexed radiating setae, which often grow out into ordinary mycelial hyphae, especially around the sides and lower part of the perithecium. The round apical pore is lined with very narrow filiform hyaline periphyses and the perithecial wall consists of 1–2 layers of olivaceous angular parenchyma enclosing an inner layer of much compressed fibrous hyaline parenchyma.

25. **Phaeophragmeriella Tecleae** Hansford, sp. n. *Mycelium* in plagulis *Meliolae* parasiticum, ex hyphis subhyalinis vel dilute olivaceis exhyphopodiatis 2–3 μ crassis obscure septatis dense reticulatis compositum. *Perithecia* laxe dispersa, globosa, atro-olivacea, 110–140 μ diam., superne setis erectis pellucide olivaceis simplicibus obtusis usque ad 50 $\times$ 4 μ saepe subtorulosis continuis ornata. *Paries perithecii* circa 5 μ crassus, parenchymaticus, subopace atro-olivaceus, ex strato uno cellularum angulosarum 5–10 $\times$ 4–7 μ et strato interiore hyalino compresso-fibroso compositus. *Asci* numerosi, basales, fasciculati, longe clavulati, sursum rotundati, haud incrassati, deorsum attenuati, subsessiles, 60–80 $\times$ 13–17 μ, 8-spori, in maturitate aparaphysati. *Sporae* parallelae, clavulato-filiformes, hyalinae, demum olivascentes, sursum rotundatae, deorsum attenuatae, 7—11-septatae, haud constrictae, leves, 60–72 $\times$ 4–5 μ.

Hab. in plagulis *Meliolae Tecleae* in foliis *Tecleae nobilis*, Entebbe Road, Uganda, *Hansford 3194 p.p.*

The perithecial wall is much thinner than that of most species of this genus, and bears more resemblance to the usual type of *Phaeodimeriella*, smooth outside and pierced by a round apical pore about 20 μ diam., with better differentiated setae around the ostiole or on the upper half, scattered in an indefinite ring of 5–15, usually more or less erect. The perithecia are entirely superficial on the mycelium, which ramifies closely over and between those of the host. What appears to be this same

species, though in immature condition, occurs in *Hansford 3179*, parasitic on *Asterina* spp. on *Syzygium cordatum*, loc. cit.

26. **Saccardomyces microspora** Hansford, sp. n. *Mycelium* in plagulis *Ireninae entebbeensis* parasiticum, ex hyphis subhyalinis vel dilute olivaceis 3–4 μ crassis obscure septatis exhyphopodiatis subagglutinatis pelliculosis compositum. *Perithecia* in greges 3–10 dense aggregata et subconfluentia, saepe plus minusve connata, singula subglobosa, atro-brunnea 50–70 μ diam. et 40–50 μ alt., astoma glabra, in maturitate superne mucoso-diffluentia. *Paries perithecii* unistratosus, rufo-brunneus, pellucidus, tenuis, primo parenchymaticus, ex cellulis angulosis levibus 5 μ diam. compositus, superne in maturitate cellulis secedentibus et massam mucosam fulvam lentam supernatentibus. *Asci* numerosissimi, basales, fasciculati aparaphysati, cylindracei, sursum rotundati, haud incrassati, sessiles, 8-spori, 25 × 6–8 μ. *Sporae* 2—3-seriatae, fusoideae, rectae, hyalinae, continuae, leves, 6–9 × 1·5–2 μ, utrinque rotundatae.

Hab. in plagulis *Ireninae entebbeensis* in foliis *Sapii elliptici*, Entebbe Road, Uganda, *Hansford 3197 p.p.*

The mature perithecium consists mainly of a tough orange-brown mass of mucus enclosing the dense layer of asci and with the remains of the thin original perithecial wall floating on the surface as very indistinct transparent cells or fragments. By reflected light under low magnifications the perithecia appear black, and are formed in dense groups, often connate into irregular compound ascomata.

27. Nectria byssiseda Rehm in Rabh.-Pazschke, Fung. extra-eur. no. 4152 (1898). On *Irenina Hansfordii* on *Acalypha* sp., Gayaza Road, Uganda, *Hansford 2653.*

28. Malacaria meliolicola Syd. in Ann. Mycol., xxviii, p. 69 (1930). On *Meliola* sp., *Hansford 3186* ; on *Hysterostomella*, *Hansford 3152.*

29. **Malacaria Meliolinae** Hansford, sp. n. *Mycelium* in plagulis *Meliolinae octosporae* parasiticum, ex hyphis subhyalinis vel dilutissime violaceis 2–3μ crassis exhyphopodiatis dense reticulatis subpelliculosis obscure septatis compositum. *Perithecia* laxe vel dense dispersa, atro-violacea vel atrobrunnea, glabra, globosa vel conoidea, 180–240 μ diam. *Paries perithecii* 7–9 μ crassus, rufo-brunneus sed colorem violaceum continens (in acetone vel in lacto-phenol qui dissolvi potest), 3-stratosus, extus plectenchymaticus ex hyphis intertextis dense septatis 6 μ crassis granulosis, medio parenchymaticus ex cellulis angulosis levibus 5–8 μ diam., intus hyalinus parenchymaticus ex cellulis compresso-fibrosis minutis compositus ; apice poro rotundato circa 30 μ diam., minute periphysato pertusus. *Asci* numerosi, basales, fasciculati, cylindracei, 110–130 × 10–12 μ, sursum rotundati haud incrassati, deorsum attenuati in stipitem circa 10–15 μ long., 8-spori. *Paraphyses* numerosae, hyalinae, filiformes, simplices vel sursum 1-furcatae, 1–2 μ crassae. *Sporae* parallelae, dilute olivaceae, anguste clavulatae, sursum rotundatae, deorsum attenuatae, 4—6-septatae haud constrictae, leves, 70–90 μ longae, sursum circa 3 μ crassae.

Hab. in plagulis *Meliolinae octosporae* in foliis *Syzygii cordati*, Entebbe Road, *Hansford 3179 p.p.*

The perithecial wall is of peculiar construction, the outer layer consisting of densely interwoven short hyphae, very pale rufous brown in

colour after the violet dye has been dissolved out in acetone or lactophenol, about 6 μ wide, closely septate and with their outer wall densely brown-granulose ; this outer layer is closely adnate to the middle layer of reddish-brown subpellucid angular parenchyma, while the innermost layer lining the loculus consists of minute, much compressed hyaline parenchyma. The violet dye of the perithecial wall also extends into the mycelial hyphae. By reflected light the perithecia appear black with a violet or brownish tinge. The apical pore is round, about 30 μ diam., and lined with short, narrow (1 μ), hyaline periphyses.

30. Cordyceps tuberculata (Leb.) Maire in Bull. Soc. Hist. Nat. Afr. Nord, viii, p. 65 (1917). In the conidial stage, *Hymenostilbe sphingum* (Schw.) Petch, on butterflies, Kawanda, Uganda, *Hansford 2560*, leg. *H. Hargreaves*.

31. **Mycosphaerella Craterispermi** Hansford, sp. n. *Maculae* angulosae 2–4 mm. diam. hypophyllae, venis folii circumdatae. *Perithecia* immersa, dense congregata, hypophylla, numerosa, globosa, atra, 120–150 μ diam., glabra, in maturitate epidermidem folii levantia et centro poro apicali 10–20 μ diam. pertusa. *Paries perithecii* parenchymaticus, 10–12 μ crassus, pluri-stratosus (cellulis angulosis 5μ diam. atro-olivaceis), intus in stratum tenue hyalinum transeuns, extus in hyphis mycelii dissolvens. *Hyphae* dilute olivaceae vel hyalinae, 1·5–2·5 μ crassae, septatae, irregulariter ramosae, inter cellulas mesophylli penetrantes ; haustoria nulla. *Asci* numerosi, basales, fasciculati aparaphysati, clavati vel saccati, apice rotundati, breviter stipitati, 8-spori, 70–80 × 20 μ. *Sporae* 2—3-seriatae, fusoideae, hyalinae, utrinque rotundatae, 1-septatae, haud constrictae, 27–30 × 5 μ, leves, cellulis aequalibus leniter curvulis.

Hab. in foliis *Craterispermi laurini*, Entebbe Road, Uganda, *Hansford 3196*.

The leaf-spots are apparent chiefly on the lower surface of the leaf, where they are yellowish and delimited by the veins of the leaf, showing above as indistinct yellow areas, not drying out ; on the lower surface, and less commonly on the upper, they are closely spotted with the dark perithecia showing through the epidermis. The perithecia are completely immersed in the leaf, but as they mature the covering epidermis becomes elevated and finally ruptures in the centre over the apical pore of the perithecium. The mycelium ramifies through the intercellular spaces of the whole mesophyll.

32. **Stegasphaeria ugandensis** Hansford, sp. n. *Maculae* minutae, 0·5 mm. diam., dense circinatim aggregatae (greges usque ad 30 mm. diam.), sursum brunneae, arescentes et leniter scabridae, deorsum brunneae, irregulares et saepius venis folii limitatae. *Perithecia* singula vel laxe dispersa, glabra, immersa, plus minusve depresso-globosa, usque ad 250 μ diam. et circa 200 μ alt., vertice epidermidem folii disrumpentia et in maturitate late aperta ; ostiolum indistinctum, vix prominens. *Paries perithecii* membranaceus, circa 10 μ crassus, atro-olivaceus, parenchymaticus, multistratosus ex cellulis angulosis compositus, concentrice fibrosus. *Asci* numerosi, basales, cylindracei, subsessiles, sursum rotundati, haud incrassati, 8-spori, circa 140 × 18 μ. *Sporae* oblique vel subtransverse 1-seriatae, subopace atrobrunneae, oblongae, utrinque late rotundatae, in medio 1-septatae et fortiter constrictae, 17–20 × 10–11 μ, cellulis aequalibus subglobosis, episporio crasse verrucoso.

Hab. in foliis *Macarangae Pynaertii*, Entebbe Road, *Hansford 3166*.

The perithecia are single or few on each leaf-spot and occupy the whole of the mesophyll, with an intercellular subhyaline mycelium penetrating the leaf; at maturity the epidermis and subepidermal layers over the apex of the perithecium are ruptured and the latter becomes widely open.

33. **Microcallis Macarangae** Hansford, sp. n. *Plagulae* hypophyllae, effusae, tenuisissimae, griseo-brunneae. Mycelium superficiale, dense reticulatum et tenuiter pelliculosum, ex hyphis dilute olivaceis vel subhyalinis 2–3·5 μ crassis dense septatis exhyphopodiatis compositum. *Hyphae* principes subrectae; ceterae irregulariter sinuosae vel tortuosae ramosissimae, omnes cuticulam folii arcte adnatae, saepe glandes folii omnino includentes. *Setae myceliales* laxe dispersae, erectae, simplices, singulae, atrobrunneae, sursum pallidiores, apice obtusae, rectae, septatae, usque ad 150 μ longae, deorsum 3–4 μ crassae, superne attenuatae (—2 μ), saepe etiam supra perithecia evolutae (0–12, dispersae). *Perithecia* sub pellicula mycelii evoluta et sursum eandem adnata, dispersa, singula, atra, depresso-globosa, 100–160 μ diam., circa 70 μ alt.; sursum stratum mycelii ex cellulis meandrice-angulosis dilute olivaceis 4–10 × 3–6 μ compositum. *Paries perithecii* parenchymaticus, 2—4-stratosus, ex cellulis hyalinis angulosis fortiter compressis 4–6 μ diam., compositus; totus 8 μ crassus; loculum singulum includens, vertice poro rotundato-anguloso circa 20 μ diam. pertusus. *Asci* circa 20, seriatim maturescentes, erecti vel apicem versus perithecii convergentes, saccati vel ellipsoidei, sursum rotundati leniter incrassatique (—2 μ), sessiles, 8-spori, 55–60 × 25 μ; paraphyses simplices, hyalinae, filiformes, evanescentes. *Sporae* 2—3-seriatae vel subconglobatae, hyalinae oblongae vel leniter clavulatae, utrinque rotundatae, leves, 1-septatae, haud constrictae, 20–22 × 7–8 μ, cellula inferiore lenissime angustiore.

Hab. in foliis *Macarangae monandrae*, Entebbe Road, Uganda, *Hansford 3167*.

The fungus forms very thin greyish-brown effuse colonies over large parts of the lower surface of the leaf, with scattered mycelial setae, which also occur in loose irregular groups of 0–12 over the perithecia. The main hyphae are almost straight, but the secondary hyphae are very sinuous-tortuous and form almost a continuous pellicle, though strongly adnate to the cuticle and often completely enclosing the leaf-glands. There is no penetration of the cuticle or stomata and the fungus is entirely superficial. The perithecia are of the usual type of Chaetothyriaceae, in which the upper part of the perithecium is covered by the adnate meandering-plectenchymatous mycelial pellicle, from which mycelial setae often arise. The true perithecial wall is thinly membranous, consisting of several layers of much flattened angular hyaline parenchyma, completely enclosing the single loculus except for the round apical pore in the middle of the upper wall, though from the exterior the shape of this pore is obscured by the irregular fracture of the outer mycelial layer. The asci are basal, erect or converging towards the apical pore, and ripen in succession.

34. **Chaetothyrium roseum** Hansford, sp. n. *Plagulae* effusae, hypophyllae, tenuissimae, aegre perspicuae. Mycelium ex hyphis subhyalinis vel dilute olivaceis 3–4 μ crassis exhyphopodiatis irregulariter ramosis sinuosis vel tortuosis laxe reticulatis compositum. *Setae myceliales*

nullae. *Perithecia* singulariter laxeque dispersa, atrobrunnea vel saepius ad laterem rufa, 140–180 μ diam., 70–100 μ alt., depresso-globosa, sursum in centro setis numerosis erecto-patentibus olivaceis continuis simplicibus obtusis 50 $\times$ 4–5 μ ornata. *Paries perithecii* hyalinus, parenchymaticus, pluristratosus, fortiter compressus, circa 10 μ crassus, sursum in pelliculam mycelii adnatus ; pellicula unistratosa, olivacea, pseudoparenchymatica, ex cellulis meandrice-angulosis 5–8 μ diam. composita et setas ferens, etiam colorem sanguineum continens (in acetone vel in lacto-phenol qui dissolvi potest). *Asci* basales cylindracei vel ellipsoidei, sursum rotundati haud incrassati, breviter stipitati, aparaphysati, 8-spori, circa 70 $\times$ 12–15 μ. *Sporae* oblique 2—3-seriatae, hyalinae, clavulato-fusoideae, utrinque rotundatae, rectae vel curvulae, 3-septatae, haud constrictae, leves, 22–25 $\times$ 4–5 μ, deorsum leniter attenuatae.

Hab. in foliis *Jasmini dichotomi*, Entebbe Road, Uganda, *Hansford 3198*.

The fungus is easily recognized by the soluble dark red dye present in the outer mycelial covering of the perithecia, also extending outwards into the mycelial hyphae. The perithecium has the typical structure of the genus, with the true perithecial wall enclosing a single loculus and adnate on the upper half, with an outer single coloured layer derived from the mycelium, and which bears numerous short setae around the ostiolar region.

35. **Aulographum Aframomi** Hansford, sp. n. *Plagulae* amphigenae, effusae, irregulares, griseae vel atrae, tenuissimae leves. *Mycelium* omnino superficiale, ex hyphis subhyalinis vel dilute olivaceis exhyphopodiatis 1·5–2 μ crassis, primariis subrectis, secondariis sinuosis vel tortuosis et dense irregulariterque ramosis indistincte septatis compositum, tenuiter pelliculosum, arcte adnatum. *Setae* nullae. *Thyriothecia* dense irregulariterque dispersa, atra, primo rotundata, demum elongato-ellipsoidea vel ramosa (X- vel Y-formia) usque ad 1500 $\times$ 80–90 μ, margine plus minusve fimbriata. *Membrana basalis* hyalina, aegre perspicue. *Membrana tegens* convexa, ex hyphis atrobrunneis radiantibus connatis 2–3 μ crassis composita, cellulis 3–10 $\times$ 2–3 μ, in maturitate longitudinaliter lateque aperta. *Asci* numerosissimi, obscure paraphysati, obovati, sessiles, sursum rotundati haud incrassati, deorsum breviter nodosi, circa 30 $\times$ 15 μ, 8-spori. *Sporae* conglobatae, hyalinae, oblongae, utrinque rotundatae, 1-septatae, leniter constrictae, leves, 10 $\times$ 4 μ, cellula inferiore angustiore.

Hab. in foliis *Aframomi* sp., Entebbe Road, Uganda, *Hansford 3163*.

This fungus is extremely common on this host throughout the district around Lake Victoria.

36. **Clypeolella Toddaliae** Hansford, sp. n. *Plagulae* epiphyllae, leves, orbiculares, atrae, subdensae, usque ad 3 mm. diam. *Mycelium* ex hyphis dilute brunneis 6–7 μ crassis (rarius ad 10 μ) rectis vel leniter flexuosis irregulariter ramosis et dense reticulatis compositum. *Hyphopodia* unilateralia vel alternata, rarius etiam opposita, hemisphaerica, 8–11 $\times$ 8–12 μ, integra, continua. *Thyriothecia* dense dispersa, arcte convexa vel subglobosa, in maturitate superne globoso-diffluentia sed marginem versus semper radianto-contexta, usque ad 140 μ diam. *Membrana basalis* obscure radiante hyalina, tenuissima. *Membrana tegens*

primo ex hyphis radiantibus dilute olivaceis 3·5–6 μ crassis, cellulis 5–8 μ longis composita ; margo integra ; in maturitate in centro cellulae secedentes et massam mucosam hyalinam supernatantes. *Asci* usque ad 20, ovati vel subglobosi, sessiles, aparaphysati, 8-spori, circa 40 × 35 μ. *Sporae* conglobatae, oblongae, utrinque rotundatae, olivascentes, 1-septatae, leniter constrictae, 21–25 × 10–12 μ, leves, cellula inferiore lenissime angustiore.

Hab. in foliis *Toddaliae aculeatae*, Entebbe Road, Uganda, *Hansford 3187 p.p.*

The fungus occurs on the same leaves with *Schiffnerula Toddaliae* Hansf., from which the colonies are easily distinguished by the naked eye, as those of the latter are scarcely visible. The thyriothecia always retain the distinct appearance of the original radiate structure of the upper wall around the edges, even when mature ; they are much larger and contain many more asci than those of *Schiffnerula Toddaliae*. The thyriothecia commence development as radiate plates of connate hyphae between the mycelium and the cuticle of the host, but in their later development, owing to production of mucus inside, they become almost globose and push up in the meshes of the mycelial hyphae.

37. **Asterina Caseariae** Hansford, sp. n. *Plagulae* amphigenae, atrae, tenues, orbiculares, usque ad 3 mm. diam., vel in confluendo irregulares multo majores. Mycelium ex hyphis dilute brunneis subrectis 4–5 μ crassis septatis (cellulis circa 30 μ longis) irregulariter ramosis et laxe reticulatis compositum. *Hyphopodia* alternata, unilateralia vel rarius opposita, 10–15 μ longa, 1-septata ; cellula basalis cylindracea, 2–4 μ longa ; cellula apicalis cylindracea, clavata vel tenuiter 2—3-lobata, recta vel curvula, 8–12 × 6–9 μ, versiformia. *Thyriothecia* dispersa, orbiculata, usque ad 140 μ diam., rarius 2-connata *Membrana basalis* subhyalina ex hyphis radiantibus 3 μ crassis gelatinosis composita. *Membrana tegens* atrobrunnea, ex hyphis radiantibus 4–5 μ crassis, cellulis 4–8 μ longis composita, margine fimbriata, hyphis fimbriarum 4 μ crassis usque ad 60 μ longis exhyphopodiatis tortuoso-radiantibus obscure septatis dilute brunneis. In maturitate thyriothecium per fissiones numerosas stellatim dehiscens, et in medio cellulis secedentibus. *Asci* usque ad 10, ovati, sessiles, circa 30 μ diam., 8-spori, aparaphysati. *Sporae* conglobatae, atrobrunneae, 16–20 × 8–9 μ, oblongae, utrinque rotundatae, 1-septatae, fortiter constrictae, cellula inferiore lenissime angustiore, episporio obscure minuteque punctato-granuloso haud echinulato. *Pycnidia* consimilia, stellatim dehiscentia ; pycnosporae numerosae, atrobrunneae, zona subhyalina praeditae, leves, continuae, oblongae vel piriformes, circa 15 × 10 μ.

Hab. in foliis *Caseariae Engleri*, Entebbe Road, Uganda, *Hansford 3182 p.p.*

This species is close to *Asterina africana* Doidge, but the spores are never echinulate as in the latter.

38. **Asterina Embeliae** Hansford, sp. n. *Plagulae* epiphyllae, orbiculares, griseo-atrae, tenues, usque ad 5 mm. diam. Mycelium ex hyphis atrobrunneis subrectis vel irregulariter flexuosis 5–7·5 μ crassis septatis (cellulis 20–35 μ longis) opposite vel irregulariter ramosis laxe anguloso-reticulatis compositum. *Hyphopodia* alternata vel irregulariter dispersa,

rarius subopposita, continua, hemisphaerica vel breviter cylindracea, sursum rotundata vel leniter crenulata, haud lobata, saepius 8–12 × 8–11 μ. *Thyriothecia* dispersa, numerosa, singula vel 2—3-aggregata et sub-connata, orbiculata 100–150 μ diam. *Membrana basalis* dilute grisea, ex hyphis radiantibus 3–5 μ crassis gelatinosis composita. *Membrana tegens* convexa, pellucide atrobrunnea, ex hyphis radiantibus 4–5 μ crassis cellulis 5–10 μ longis composita, margine crenata haud fimbriata, in maturitate irregulariter stellatim dehiscens, cellulis centralibus secedentibus. *Asci* plerumque 4–8, subglobosi, sessiles, 40–50 μ diam., 8-spori aparaphysati. *Sporae* conglobatae, oblongae, utrinque rotundatae, atrobrunneae, 1-septatae, fortiter constrictae, leves, 26–28 × 13–15 μ, cellula inferiore lenissime angustiore.

Hab. in foliis *Embeliae Schimperi*, Entebbe Road, Uganda, *Hansford 3173.*

39. **Asterina Grewiae** Cooke, var. **granulosa** Hansford, var. n. *Plagulae* epiphyllae, effusae, numerosae, confluentes, irregulares, tenues, atrae, leves. *Mycelium* ex hyphis dilute brunneis 3–4·5 μ crassis subrectis vel sinuoso-flexuosis plerumque opposite ramosis subdense reticulatis compositum (hyphis obscure septatis, cellulis plerumque 20–30 μ longis). *Hyphopodia* numerosa, alternata vel opposita, continua, plus minusve erecta, digitata vel sub-sinuosa, rarius sublobata, 8–12 × 4–6 μ. *Thyriothecia* dense dispersa, singula vel 2—3-connata, orbiculata, 110–130 μ diam. *Membrana basalis* hyalina vel subhyalina, obscure radiata. *Membrana tegens* convexa, atrobrunnea, ex hyphis radiantibus 3–4 μ crassis, cellulis 4–6 μ longis composita, margine aegre fimbriata, hyphis fimbriarum paucis usque ad 30 μ longis plerumque lateraliter connatis, in maturitate per fissiones numerosas stellatim dehiscens, cellulis centralibus secedentibus. *Asci* usque ad 15, ovati vel subglobosi, sessiles, aparaphysati, 8-spori, circa 30 μ diam. et 35–40 μ alt. *Sporae* conglobatae, atrobrunneae, oblongae, utrinque rotundatae, 1-septatae fortiter constrictae 20–24 × 11–13 μ, cellulis aequalibus vel inferiore leniter angustiore, episporio minute distincte punctato-granuloso. *Pycnidia* thyriothecis consimilia ; pycnosporae atrobrunneae ovato-ellipsoideae vel piriformes, continuae, leves, 17–21 × 10–12 μ ; zona subhyalina nulla ; porae germinationis 6–8, dispersae.

Hab. in foliis *Scolopiae* sp., Entebbe Road, Uganda, *Hansford 3193.*

Differs from the type in the finely granulose-punctate ascospores and in the germ-pores of the pycnospores.

40. Asterina erysiphoides Kalchbr. & Cooke, forma. On *Jasminum dichotomum*, Entebbe Road, *Hansford 3201.*

Colonies hypophyllous, thin, black, smooth, orbicular or irregular, up to 5 mm. diam. Mycelium of very sinuous to tortuous pale brown hyphae 2·5–4 μ wide, septate at intervals of 20–30 μ, the septa rather indistinct, branching irregularly to form a loose network of rounded meshes. Hyphopodia mostly alternate or unilateral, but frequently opposite, mostly 1-septate, 10–28 μ long ; stalk-cell cylindric, variously bent to tortuous, 5–18 × 2·5–3 μ ; head-cell very variable in shape, deeply 3—5-lobed or sinuous-lobed, 8–10 μ long by 4–9 μ wide ; the continuous hyphopodia similar to the head-cells of the capitate hyphopodia in shape and size. Thyriothecia scattered, usually discrete and circular,

80–120 μ diam., sometimes 2—3-connate into irregular compound ascomata; basal membrane delicate hyaline to pale olive, composed of radiating hyphae 2·5–3 μ wide ; covering membrane strongly convex, dark brown, composed of radiating hyphae 2·5–4 μ wide, the cells about 5 μ long ; margin loosely fimbriate, the fringing hyphae tortuous, up to 50 μ long, exhyphopodiate ; dehiscence by stellate fissures into numerous triangular segments to the margin. Asci up to about 12, ovate, sessile, 30–35 × 25–30 μ, 8-spored, aparaphysate. Spores conglobate, brown, oblong, with rounded ends, 1-septate, deeply constricted, from minutely granulose to finely echinulate, 18–25 μ long ; upper cell usually subglobose, 11–13 × 10–12 μ, lower cell 10–12 × 8–10 μ. Pycnidia variable in number, from very few to numerous, similar to the thyriothecia, 60–80 μ diam. ; pycnospores brown, without a hyaline band, ovate to piriform, smooth, 16–20 × 10–14 μ.

This differs from the type as described by Doidge in Bothalia, IV, p. 304 (1942) in the very long hyphopodia, which are frequently opposite.

41. **Asterina Landolphiae** Hansford, sp. n. *Plagulae* hypophyllae. griseae vel atrae, orbiculares, usque ad 5 mm. diam. vel in confluendo majores, irregulares. *Mycelium* ex hyphis dilute brunneis subrectis vel irregulariter flexuosis 2–3 μ crassis septatis (cellulis 20–40 μ longis) alternatim vel irregulariter ramosis laxe reticulatis compositum. *Hyphopodia* alternata vel unilateralia, 1-septata, 10–20 μ longa ; cellula basalis cylindracea, recta vel flexuosa, 2–12 × 2–3 μ ; cellula apicalis ovata vel irregularis, recta vel curvata, interdum plus minusve lobata, 7–10 × 4–8 μ. *Thyriothecia* dispersa, numerosa, orbiculata, 100–170 μ diam., saepe pluria connata in ascomatibus irregularibus, usque ad 600 × 130 μ. *Membrana basalis* obscure fibrosa, hyalina. *Membrana tegens* atrobrunnea, convexa, ex hyphis radiantibus 2·5–3 μ crassis cellulis 3–6 μ longis composita, margine plus minusve fimbriata, hyphis fimbriarum tortuoso-radiantibus exhyphopodiatis usque ad 60 μ longis et 2–3 μ crassis, in maturitate per fissiones paucas stellatim dehiscens et cellulis centralibus secedentibus. *Asci* numerosi, ovati, 30–40 × 15–23 μ, sessiles, aparaphysati, 8-spori. *Sporae* multiseriatae vel sub-conglobatae, oblongae, utrinque rotundatae, brunneae, in medio 1-septatae, leniter constrictae, leves, 17–19 × 6–7 μ, cellula inferiore leniter angustiore.

Hab. in foliis *Landolphiae floridae*, Entebbe Road, *Hansford 3156*.

42. **Asterina Syzygiicola** Hansford, sp. n. *Plagulae* amphigenae, orbiculares vel in confluendo irregulares, atrae, leves, usque ad 4 mm. diam. *Mycelium* ex hyphis atrobrunneis 4–6 μ crassis septatis (cellulis 20–30 μ longis) sinuosissimis irregulariter ramosis dense reticulatis compositum. *Hyphopodia* alternata vel unilateralia, rarius opposita, plerumque plus minusve antrorsa, 1-septata, 10–13 μ longa ; cellula basalis breviter cylindracea ; cellula apicalis ovata vel cylindracea sursum rotundata, integra, 7–8 × 6–7 μ. *Thyriothecia* laxe dispersa, atra, orbiculata vel elliptica, usque ad 400 μ longa et 240 μ crassa, interdum 2—3-connata. *Membrana basalis* obscura. *Membrana tegens* opace atrobrunnea, ex hyphis radiantibus 5–6 μ crassis, cellulis 6–12 μ longis composita, margine crenata vel fimbriata, hyphis fimbriarum exhyphopodiatis plus minusve tortuoso-radiantibus connatisque usque ad 60 μ longis ; in maturitate membrana per fissiones irregulariter longitudinaliter

dehiscens, cellulis centralibus secedentibus. *Asci* numerosi, sessiles, ovati, 8-spori, aparaphysati, 70×50–$60\,\mu$. *Sporae* conglobatae, atrobrunneae, oblongae, utrinque rotundatae, 1-septatae, leniter constrictae, 30–32×15–$17\,\mu$, cellulis subaequalibus vel inferiore leniter angustiore, episporio obscure minute punctato in maturitate subopaco ; utraque cellula zona pallidiore praedita.

Hab. in foliis *Syzygii cordati*, Entebbe Road, Uganda, *Hansford 3179 p.p.*

In the shape of the thyriothecia this species is intermediate between *Asterina* and *Lembosia* ; though they commence as circular radiate plates, the mature ascomata are often elliptic to elongate and the composite ascomata are frequently Y-shaped, as in the latter genus, with more or less longitudinal dehiscence, though in the smaller thyriothecia dehiscence is often by several radiating fissures. The developing ascospores are often distinctly punctate, but this appearance disappears at full maturity, when the spores are subopaque dark brown, with a rather indistinct lighter zone around each cell in many spores.

43. **Asterina Syzygii** Doidge, var. **microspora** Hansford, var. n. *Plagulae* amphigenae, tenues, atrae, leves, orbiculares, usque ad 4 mm. diam. *Mycelium* ex hyphis brunneis 4–$5\,\mu$ crassis, septatis (cellulis 12–$20\,\mu$ longis) leniter sinuosis vel subrectis irregulariter ramosis laxe reticularibus compositum. *Hyphopodia* unilateralia vel alternata, saepe in cellulis alternatis mycelii evoluta, continua, hemisphaerica vel breviter cylindracea, rotundata, integra, 7–$10 \times 7\,\mu$, brunnea, inferne poro conspicuo perforata. *Thyriothecia* dispersa, rotundata usque ad $200\,\mu$ diam. *Membrana basalis* obscure radiata, hyalina vel subhyalina. *Membrana tegens* atrobrunnea in centro subopaca, convexa, ex hyphis radiantibus 4–$6\,\mu$ crassis composita, cellulis 5–$10\,\mu$ longis, margine plus minusve fimbriata, hyphis fimbriarum exhyphopodiatis pallidioribus tortuoso-radiantibus usque ad 100μ longis obscure septatis ; in maturitate membrana per fissiones numerosas stellatim dehiscens, cellulis centralibus secedentibus. *Asci* ovati vel ellipsoidei, sessiles, aparaphysati, 8-spori, circa $45 \times 35\,\mu$. *Sporae* conglobatae, atrobrunneae, oblongae, utrinque rotundatae, 1-septatae, constrictae, 31–24×10–$12\,\mu$, leves, cellula superiore subglobosa, inferiore deorsum attenuata et 9–11×7–$9\,\mu$.

Hab. in foliis *Syzygii cordati*, Entebbe Road, Uganda, *Hansford 3179 p.p.*

This is easily distinguished from the preceding species occurring on the same leaves by the naked eye, the colonies being thinner and the thyriothecia usually smaller. It differs from the type as described by Doidge in Bothalia, IV, p. 284 (1942) in the smaller spores. The distribution of the hyphopodia which arise from alternate cells of many hyphae is peculiar.

44. **Asterina Turraeae** Hansford, sp. n. *Plagulae* epiphyllae, leves, tenues, atrae, orbiculares, usque ad 3 mm. diam., laxe dispersae. *Mycelium* ex hyphis atrobrunneis sinuosis 4–$5\,\mu$ crassis septatis (cellulis 12–$30\,\mu$ longis) laxe reticulatis opposite vel irregulariter ramosis compositum. *Hyphopodia* alternata vel unilateralia, continua, cylindracea vel leniter sinuosa, rarissime sublobata, recta vel curvata, 10–15×5–$9\,\mu$. *Thyriothecia* dispersa, orbicularia, usuqe ad $140\,\mu$ diam., raro 2—3-connata.

Membrana basalis hyalina obscura ; membrana tegens convexa, subopace atrobrunnea, ex hyphis radiantibus 3–4·5 μ crassis cellulis 4–9 μ longis composita, margine plus minusve fimbriata, hyphis fimbriarum flexuosis vel tortuosis, exhyphopodiatis septatis usque ad 60 μ longis et 3–4 μ crassis ; membrana per fissiones numerosas stellatim dehiscens, cellulis centralibus secedentibus. *Asci* usque ad 10, ovati vel subglobosi, sessiles 8-spori, aparaphysati, circa 40×35 μ. *Sporae* conglobatae, atrobrunneae vel subopacae, oblongae, utrinque rotundatae, 1-septatae fortiter constrictae, 23–26×11–12 μ, cellulis subaequalibus, episporio dense minuteque verruculoso.

Hab. in foliis *Turraeae floribundae*, Entebbe Road, Uganda, *Hansford 3174 p.p.*

45. **Patouillardina Sersalisiae** Hansford, sp. n. *Plagulae* hypophyllae, tenuissimae, griseo-brunneae, effusae, saepe confluentes. *Mycelium* ex hyphis dilute brunneis 3–4 μ crassis septatis (cellulis 30–45 μ longis) irregulariter ramosis flexuosis vel sinuosis laxe reticulatis compositum. *Hyphopodia* pauca, dispersa, versiformia, 1-septata ; cellula basalis cylindracea flexuosa 5–25 μ longa ; cellula apicalis cylindraceo-curvula vel sinuosa vel lobata, 7–10×3–5 μ. *Thyriothecia* laxe dispersa orbiculata usque ad 160 μ diam., atrobrunnea. *Membrana basalis* hyalina obscure radiata. *Membrana tegens* atrobrunnea, ex hyphis radiantibus 4–5 μ crassis, cellulis 5–10 μ longis composita, margine fimbriata, hyphis fimbriarum tortuoso-radiantibus exhyphopodiatis usque ad 60 μ longis ; membrana in maturitate per fissiones paucas stellatim dehiscens, cellulis centralibus secedentibus. *Asci* in muco subhyalino vel fulvo inclusi. aparaphysati, oblongi vel ellipsoidei, sessiles vel brevissime nodoso-stipitati, sursum rotundati haud incrassati, erecti, 45×13–15 μ, 8-spori. *Sporae* parallelae, hyalinae, demum dilute brunnescentes, cylindraceae, utrinque rotundatae, rectae vel curvulae, 4-septatae, haud constrictae, leves, 35×4 μ.

Hab. in foliis *Sersalisiae* sp., Entebbe Road, Uganda, *Hansford 3186 p.p.*

The hyphopodia are very variable and often resemble short lateral branches of the mycelium ; frequently two or three meet over a single stoma of the host, and each sends a very fine filament through the stomatal pore to form a small, minutely coralloid-granular haustorium inside the epidermal cells next behind the guard cells. In some cases the filament connecting the haustorium to the hyphopodium appears to penetrate the cuticle above the guard cell to the neighbouring epidermal cell ; the fungus is not parasitic on the guard cells themselves, and not on other cells of the epidermis save those immediately next the stomata. The thyriothecia are early stellate dehiscent and the upper wall becomes widely open to enclose or merely surround a mass of hyaline to yellow-brown mucilage in which the asci are embedded.

46. Asterinella Tecleae, Doidge in Bothalia, iv, p. 316 (1943). On leaves of *Teclea aculeata*, Kiterera, Busoga, Uganda, *Hansford 2829* ; Entebbe Road, Uganda, *Hansford 2857, 3194.*

Many short lateral branches of the mycelial hyphae reach the stomata, where they form small, swollen, terminal cells, usually entire and ovate, up to 10×5 μ, penetrating down to the guard cells. Haustoria are

formed in single epidermal cells around the stomata, but not in the guard cells themselves ; it has not been possible as yet to discover in what manner these haustoria are connected to the external hyphae, whether direct through the cuticle or by way of the stomatal pore.

47. **Asterostomella Rhaphiostylidis** Hansford, sp. n. *Plagulae* amphigenae, orbiculares, tenues, griseo-atrae, leves, usque ad 8 mm. diam. vel in confluendo majores. *Mycelium* ex hyphis brunneis flexuosis vel subrectis 3·5–4·5 μ crassis septatis (cellulis 15–35 μ longis) irregulariter ramosis laxe reticulatis compositum. *Hyphopodia* alternata, unilateralia vel saepius opposita vel 3-aggregata, 1-septata, 11–26 μ longa ; cellula basalis 4–20 μ longa, cylindracea recta vel curvula ; cellula apicalis ovata, clavata vel cylindracea, integra, 7–11 × 6–8 μ. *Pycnidia* dispersa, orbiculata, atra, usque ad 80 μ diam. ; membrana basalis obscura, hyalina ; membrana tegens convexa, atrobrunnea, ex hyphis radiantibus 3–4 μ crassis cellulis 5–10 μ longis composita, in maturitate stellatim vel irregulariter dehiscens, cellulis centralibus secedentibus, margine fimbriata, hyphis fimbriarum tortuoso-radiantibus exhyphopodiatis obscure septatis usque ad 80 μ longis. *Pycnosporae* subglobosae, subopace atrobrunneae, leves, continuae, 20–25 × 18–21 μ, haud zonatae, interdum basi breviter apiculatae.

Hab. in foliis *Rhaphiostylidis beninensis*, Entebbe Road, Uganda, *Hansford 3191.*

48. **Clypeolum Caseariae** Hansford, sp. n. *Mycelium* liberum non visum. *Scutella* brunnea, orbiculata, usque ad 400 μ diam., dispersa levia, circa 12 μ alt. *Membrana tegens* meandrice plectenchymatica, dilute brunnea, cellulis 3–10 × 3–5 μ, hyphis intertextis obscure septatis in centro poro indistincto pertusa. *Asci* numerosi in hymenium unum dispositi, aparaphysati, globosi, 26–30 μ diam., 8-spori, sessiles. *Sporae* hyalinae, ellipsoideo-clavulatae, utrinque rotundatae, 1-septatae, non vel vix constrictae, leves, 16–18 × 6·5–7 μ, cellula inferiore saepius leniter angustiore ; sporae in asco conglobatae.

Hab. in foliis *Caseariae Engleri*, Entebbe Road, Uganda, *Hansford 3182 p.p.*

49. **Mycolangloisia Hysterostomellae** Hansford, sp. n. *Mycelium* in stromatibus *Hysterostomellae* parasiticum, ex hyphis dilute olivaceis vel subhyalinis exhyphopodiatis obscure septatis 2–3 μ crassis irregulariter ramosis saepius lateraliter 2—4-agglutinatis compositum. *Thyriothecia* sub hyphis mycelii evoluta et cum eisdem circum ostiolum connexa, depresso-conoidea, usque ad 200 μ diam. et 50–80 μ alt., atrobrunnea, in maturitate subopaca ; paries unistratosus ex hyphis radiantibus 4 μ crassis, cellulis 4–8 μ longis compositus, circum verticem parenchymaticus atque ater et circulo setarum ornata ; setae radiantes, 6–15, rectae, simplices, acutae, opace atrobrunneae, usque ad 50 μ longae et basi 5–7 μ crassae, etiam circum verticem hyphis radiantibus mycelii solum connexae. *Asci* numerosi, basales, ostiolum versus centripetaliter directi, ellipsoidei vel subsaccati, sursum rotundati leniter incrassati (−3 μ), sessiles vel breviter nodoso-stipitati, 8-spori, circa 50 × 15 μ. *Paraphyses* indistinctae, filiformes, mucosae. *Sporae* 2—3-seriatae, plus minusve obliquae, hyalinae, oblongae vel clavulatae, utrinque rotundatae, 1-septatae, non vel vix constrictae, leves, 14–16 × 5 μ, cellula inferiore leniter angustiore longiore.

Hab. in plagulis *Hysterostomellae Tetracerae* in foliis *Tetracerae potatoriae*, Entebbe Road, Uganda, *Hansford 3152*.

The mycelium is parasitic on the mycelium and ascomata of the host fungus and is connected to the thyriothecia only at their vertices, which are pierced by a round apical pore about 20 μ wide. The thyriothecial wall is subopaque dark brown and, except for the dark apical region, consists of hyphae arranged in meridians from the vertex to the centre of the flat base, laterally connate and septate into short cells, arranged in a single layer. Between the radiating mycelial hyphae around the apex, and slightly above them, there is a ring of up to 15 radiating dark stiff setae. The asci appear to be formed over the whole base of the thyriothecium and are centripetally directed towards the apical pore, maturing in succession and then collapsing ; the indistinct filiform paraphyses present in young thyriothecia appear to dissolve into mucus at full maturity.

50. **Lecideopsella Landolphiae** Hansford, sp. n. *Ascomata* hypophylla, laxe dispersa, singula, tenuiter discoidea vel leniter pulvinata, usque ad 180 μ diam. et 40 μ alt., dilute vel atro-brunnea, omnino superficialia et facile secedentes. *Mycelium* tenue ex hyphis paucis brevibus radiantibus hyalinis 2 μ crassis ramosis flexuosis obscure septatis, septis saepius obscuris. *Ascoma* sursum in epithecio tenui 4–5 μ crasso inclusum, ex hyphis dilute brunneis tortuosis 2 μ crassis ramosissimis compositum, in maturitate disrumpens, verisimiliter ex ramulis terminalibus paraphysium evolutum. *Asci* singulariter dispersi, erecti, obovati vel saccati, sursum rotundati, deorsum contracti, sessiles, recti vel curvati, 8-spori, 30 × 15 μ. *Paraphyses* numerosae, hyalinae, filiformes, 1 μ crassae, irregulariter ramosae, tortuosae, sursum cum epithecio et deorsum cum hypothecio connexae, texturam laxam fibrosam hyalinam efformatantes. *Hypothecium* hyalinum, laxe fibrosum, tenuissimum. *Sporae* 2—3-seriatae, obliquae, oblongae, utrinque rotundatae, hyalinae, leves, 1-septatae, leniter constrictae, 12–13 × 4 μ, cellula inferiore leniter angustiore.

Hab. in foliis *Landolphiae floridae*, Entebbe Road, Uganda, *Hansford 3162 p.p.*

51. Puccinia Magnusiana Korn. in Hedwigia, 1876, p. 179. On *Phragmites mauritianus*, Entebbe Road, Uganda, *Hansford 3146*.

52. Exobasidium hesperidium Maire in Bull. Station Rech. Forest. Nord-Afrique, 1917, p. 183. On leaves of *Rhus glaucescens*, Kazi, Kampala, Uganda, *Hansford 2329, 2858*.

Both these specimens came from the same individual host-plant, and although this species of *Rhus* is one of the commonest constituents of the bush flora around Lake Victoria, hitherto no other plant has been found infected with this *Exobasidium*.

53. Septoria Gerberae Syd. in Ann. Mycol. x, p. 43 (1912). On leaves of *Gerbera Jamesonii*, Kawanda, Kampala, Uganda, causing severe leaf-spotting and defoliation, especially in dry hot weather, controlled by light shading of the plants.

54. Coniodictyum Chevalieri Har. & Pat. in Bull. Soc. Mycol. France, xxv, p. 13 (1909). Causing large hemispherical galls on the fruits of *Zizyphus mauritianus*, Bugerere, Uganda, *Hansford 2804*, leg. *H. Hargreaves*.

In culture on agar media the fungus forms a smooth yellowish-white colony, producing conidia all over the surface on short stalks, and exactly similar to those on the host, arising directly from the fine hyaline hyphae of the mycelium.

55. Neobarclaya congesta (Berk. & Br.) Petch in Ann. Roy. Bot. Gard. Peradeniya, ix, p. 165 (1924). Syn. *Pestalozzia congesta* Berk. & Br. in Journ. Linn. Soc. Lond., xiv, p. 89 (1875) : *N. natalensis* Syd. On *Syzygium cordatum* leaves, Entebbe Road, Uganda, *Hansford 3179 p.p.*

The acervuli are completely sunken in the leaf-tissues and occupy the whole mesophyll, mostly opening on the upper surface to discharge the spores, up to 500 μ diam. inside the leaf and 60 μ high, often irregular in horizontal outline and almost multilocular, surrounded by a hyaline wall or aggregation of mycelial hyphae about 10 μ thick, on the inside of which the continuous layer of erect, short, continuous, simple cylindric conidiophores is borne ; conidiophores about 10 μ long by 3 μ wide, each forming a single terminal conidium. Conidia oblong, rounded at the apex, truncate at the base, 1-septate, not constricted, the upper cell longer than the lower and just above the septum surrounded by a hyaline zone about 3–4 μ wide, the remainder of the body of the conidium dark olivaceous brown, wholly smooth ; the whole conidium body 20–25 $\times$ 7–9 μ, with a small hyaline apical apiculus bearing four radiating hyaline, filiform, solid setae up to 50 μ long by 1 μ thick. The conidia are discharged through an ' ostiole ' in either the upper or lower epidermis of the leaf, about 20–30 μ diam. and lined with delicate periphyses, which may merely be immature conidiophores.

56. Papularia sphaerosperma (Pers. ex Fr.) von Hoehnel in Fragm. z. Mykol., no. 990 (1916). On dead stems of *Phragmites*, Kawanda, Kampala, Uganda, *Hansford 2758*.

57. Polythrincium Trifolii Kunze ex Fr. in Mykol., Hefte i, p. 13 (1817). On *Trifolium pseudostriatum*, Toro, Uganda, *Hansford 2624*, leg. *G. Hancock*.

58. **Helminthosporium cupuliferum** Hansford, sp. n. *Mycelium* in plagulis *Asterinae* parasiticum, ex hyphis dilute olivaceis 2–3 μ crassis septatis exhyphopodiatis ramosis dense reticulatis compositum. *Conidiophora* erecta, plus minusve fasciculata, atro-brunnea, simplici, 2—5-septata, usque ad 200 $\times$ 5–6 μ, recta vel superne leniter geniculata. *Conidia* singula, terminalia, obclavata, 3—(4)-septata, 40–50 $\times$ 7–8 μ, basi abrupte attenuato-rotundata, ad hilum planum 3 μ diam., apice longe attenuata 2 μ diam., cellulis centralibus atrobrunneis ; cellula apicalis pallidior : cellula basalis zona subhyalina 3 μ cr. praedita. *Cicatrices conidiorum* cupuliformes, 5–6 μ diam. et 2–3 μ long., hyalinae sed in centro brunneae.

Hab. in plagulis *Asterinae* sp. in foliis *Syzygii cordati*. Entebbe Road, Uganda, *Hansford 3179 p.p.*

This species is distinguished from all others hyperparasitic on *Asterina* and *Meliola* by the prominent large cupulate conidial scars, which become lateral on the conidiophore as it elongates after production of each conidium. The base of the young conidium fits closely into the cupulate scar, which remains as a thickened hyaline ring with a central thin dark wall on the conidiophore, while the basal cell of the conidium

elongates after separation from the conidiophore, and forms a hyaline thin-walled zone just above the terminal dark hilum ; through this zone germination occurs, as well as by prolongation of the light, narrow, apical beak.

59. **Mitteriella Craterispermi** Hansford, sp. n. *Plagulae* epiphyllae, atrae, leves, tenues, saepius numerosae, confluentes, irregulares. *Mycelium* ex hyphis dilute brunneis rectis vel sinuosis 5–7 μ crassis septatis (cellulis circa 25 μ longis) irregulariter ramosis laxe reticulatis compositum. *Hyphopodia* alternata vel unilateralia, hemisphaeria vel ovata, concolorata, continua, 9–12 × 8–10 μ, integra. *Conidia* singulariter in sterigmatibus brevibus evoluta, in cellulis lateralibus hypharum secondariarum tortuosarum mycelii, late clavata, curvata, sursum rotundata, basi attenuata in hilum planum, 27–32 × 14–16 μ ; cellula secunda atrobrunnea, subopaca, subglobosa, 14–16 μ longa ; aliae (3) pallidiore minore.

Hab. in foliis *Craterispermi laurini*, Entebbe Road, Uganda, *Hansford 3196 p.p.*

The fungus has the typical appearance of a *Schiffnerula*, but no perithecia were found ; it is closely similar to *M. zizyphina* Syd.

60. **Cercospora acanthicola** Hansford, sp. n. *Maculae* dispersae, angulosae, 5–8 mm. diam., sursum primo flavidae demum brunnescentes, deorsum rufobrunneae, venis folii delimitatae. *Conidiophora* fasciculata, erecta, simplicia vel sursum irregulariter 1—2-furcata, atro-olivacea vel rufo-brunnea, 3—10-septata, flexuosa vel noduloso-geniculata, 150–250 × 4–6 μ. *Conidia* terminalia, saepe 2—3-catenulata, subhyalina vel dilute brunnea, 0—4-septata, cylindracea utrinque rotundata, haud constricta, levia, recta vel curvula, 20–90 × 4–6 μ, membrana tenui, facile collapsa.

Hab. in foliis *Acanthi arborei*, Kawanda, Kampala, Uganda, *Hansford 3144.*

The leaf-spots are at first yellowish, becoming brownish as the conidiophores are formed through the stomata of the lower surface in bundles of up to 10, and finally remaining dark greenish brown long after the remainder of the leaf has turned yellow with age. The conidia are formed in terminal chains which may be branched in a manner similar to those of *Cladosporium*. Each conidium has a terminal flat hilum, not projecting markedly from the curve of the basal cell, and slightly darker than the rest of the wall.

61. **Cercospora** (?) **jasminicola** Hansford, sp. n. *Plagulae* effusae, hypophyllae, tenues vel atro-velutinae. *Mycelium* omnino superficiale, ex hyphis exhyphopodiatis subhyalinis vel dilute olivaceis septatis 2–3 μ crassis irregulariter ramosis laxe reticulatis compositum. *Conidiophora* erecta, atro-brunnea laxe fasciculata, (—10)-septata usque ad 250 μ alt., sursum 6 μ crassa, deorsum attenuata, ramosa ; rami descendentes et ad cuticulam folii in hyphis mycelii transeuntes. *Conidia* singula, terminalia, longe obclavata, olivacea, sursum attenuata pallidiora, basi rotundato-attenuata et hilo plano atro praedita, 7—11-septata haud constricta, levia, usque ad 200 μ longa, deorsum circa 10 μ crassa, apice circa 3 μ crassa.

Hab. in foliis *Jasmini dichotomi*, Entebbe Road, Uganda, *Hansford 3200.*

The fungus causes no leaf-spots, and the mycelium appears to be completely superficial, ramifying loosely over the cuticle. At intervals the ends of the hyphae become erect, or short branches may turn upwards to form the young conidiophore, which is almost opaque dark brown and wider than the hyphae. As the conidiophore elongates, lateral branches arise from its cells below the apex, and descend to the leaf, where they radiate outwards as ordinary mycelial hyphae. The conidia are formed singly and terminal on the ends of the conidiophore, in a manner similar to that of other species of the genus ; they are obclavate and with a very long, narrow, pale, apical beak. In view of the very doubtful parasitism of this species and of the peculiar structure of the conidiophore, it seems doubtful whether this fungus should be placed in *Cercospora*, but we know of no other genus to which it could be referred.

62. **Cercospora Phyllanthi** Hansford, sp. n. *Caespituli* amphigeni, effusi, atro-olivacei. *Maculae* nullae. *Conidiophora* erecta, fasciculata (—100), ex stromate 50 μ diam. et 20–30 μ alt. oriunda, simplicia atro-olivacea, superne pallidiora, septata, geniculata, usque ad 250 × 4–6 μ. *Conidia* pallide olivacea, obclavata, apice attenuato-rotundata, basi truncata, curvata vel sigmoidea, 3—6-septata, 30–60 × 4–7 μ.

Hab. in foliis *Phyllanthi discoidei*, Entebbe Road, Uganda, *Hansford 3016*.

This differs from *Helminthosporium Phyllanthi* Sacc. in the much shorter and narrower conidia ; in the present specimen it is associated with *Aecidium Phyllanthi* P. Henn., but also occurs separately on the same leaves.

63. **Cercospora Tremae** Hansford, sp. n. *Maculae* nullae ; plagulae hypophyllae, effusae, dilute olivaceae. *Conidiophora* dispersa vel fasciculata, erecta, ex hyphis mycelii repentis oriunda, dilute olivacea vel brunnea, 1—2-septata, 50–110 × 5–7 μ, simplicia vel rarius furcata, superne nodulosa. *Conidia* subhyalina vel dilute olivacea, filiformia, 10—20-septata, haud constricta, 70–200 × 5–7 μ, deorsum leniter attenuata, hilo primo truncato demum rotundato praedita, antice attenuata (— 3 μ).

Hab. in foliis *Tremae guineensis*, Rifle Range, Kiagwe, Uganda, *Hansford 2697*.

The fungus forms effuse olivaceous patches on the lower leaf-surface, showing above sometimes as indefinite yellowed areas, but not forming definite leaf-spots. The conidiophores arise from hyphae creeping over the lower epidermis and not from sub-stomatal stromata. In the formation of successive conidia the apex of the conidiophore grows through the old scar and not past it as in many species of *Cercospora*, so that the old scars do not remain on the conidiophore axis as prominent thickenings and geniculations.

64. **Cercosporella Thunbergii** Hansford, sp. n. *Caespituli* hypophylli, albidi, tenues pulverulentes areas angulatas folii usque ad 5 mm. diam. efformantes. *Conidiophora* fasciculata, per stomata folii erumpentia, hyalina, simplicia vel irregulariter furcata, usque ad 100 μ longa et 4–5 μ crassa, septata, superne geniculata. *Conidia* terminalia, singula vel 2—3-catenata, cylindracea, recta vel leniter curvata, utrinque rotundata vel truncata, 0—4-septata haud constricta, levia, 20–60 × 4–5 μ.

Hab. in foliis *Thunbergiae* sp., Kazi, Kampala, Uganda, *Hansford 3073*.

The fungus forms very thin, white, pulverulent layers over the lower surface of leaf-spots up to 5 mm. diam., limited by the larger veins of the leaf, and appearing above as indistinct yellow-brown areas. In structure it resembles a hyaline, large *Cladosporium*, but there is no trace of colour in mycelium, conidiophores or conidia.

65. **Cercosporella Antiaridis** Hansford, sp. n. *Maculae* nullae vel areolas, obscuras flavo-viridas in hypophyllo formantes. *Mycelium* intercellulare ex hyphis ramosis septatis hyalinis 2–3 μ crassis compositum. *Conidiophora* per stomata fasciculatim (—100) erumpentia (stroma basale obscurum), hyalina erecto-divergentia, saepius simplicia, usque ad 150 μ longa, 3–4 μ crassa, septata, superne geniculata. *Conidia* singula, terminalia, cylindracea vel filiformia, 1—6-septata, haud constricta, levia, sursum ad 2–3 μ attenuata, apice rotundata, basi abrupte attenuato-rotundata et hilo plano minuto praedita, 40–130 × 4–5 μ.

Hab. in foliis *Antiaridis toxicariae*, Entebbe Road, Uganda, *Hansford 3112*.

No definite leaf-spots are formed, but sometimes indefinite pale green areas are produced on the lower side of the infected leaf, which falls prematurely. The conidiophores and conidia form a loose velvety layer over the infected parts.

66. **Cercosporella Beckeropsidis** Hansford, sp. n. *Maculae* indefinitae, flavidae vel pallide viridae, ellipticae vel lineares, saepius confluentes et in centro brunnescentes, arescentes, in hypophyllo albo-velutinae, usque ad 25 × 3–6 mm. *Mycelium* intramatricale inter cellulas folii penetrans, ex hyphis hyalinis 1–2 μ crassis indistincte septatis compositum, sub stomatibus stroma pseudoparenchymaticum hyalinum efficiens. *Conidiophora* dense 20–100-fasciculata, erecta vel divergentia hyalina 0—1-septata, simplicia vel furcata, usque ad 25 × 2 μ. *Conidia* 2—4-catenulata, hyalina, fusoidea, utrinque subattenuata, 0—1—2-septata, recta vel curvula, levia, haud constricta, 8–25 × 1·5–2 μ.

Hab. in foliis *Beckeropsidis unisetae*, Kawanda, Kampala, Uganda, *Hansford 3094*.

The leaf-spots are indefinite yellow to pale green elliptic to linear areas, elongated along the leaf and often confluent over large areas, becoming pale brown in the centre and drying out, covered, chiefly on the lower surface, with a more or less continuous white layer of conidiophores and conidia. The conidia are produced in short terminal, simple or branched chains of 2–4 on the conidiophores, and all parts of the fungus are completely hyaline.

67. **Verticicladium Grewiae** Hansford, sp. n. *Caespituli* tenues, albidae vel griseae, effusae, laxe velutinae, hypophyllae. *Conidiophora* singulariter dispersa vel laxe fasciculata, per stomata oriunda, erecta, recta vel leniter flexuosa, cylindracea, 100–300 × 4–5 μ, deorsum olivacea, sursum verticillato-ramosa, ramis 2—3-verticillatis; ramulis terminalibus 7–20 × 3–3·5 μ, hyalinis scabridis vel geniculatis. *Conidia* acro-pelurogenea, sub-capitata, globosa, hyalina vel subhyalina, continua, 6–9 μ diam., episporio verrucoso.

Hab. in foliis *Grewiae nyanzae*, Entebbe Road, Uganda, *Hansford 3157 p.p.*

The fungus forms a whitish mouldy growth on and around the brown leaf-spots caused by ? *Mycosphaerella* sp. The conidiophores arise singly

or in small loose fascicles through the stomata, or sometimes singly and direct through the dead epidermis of the leaf-spots ; they are olivaceous below and paler above, where they are 2–3 times verticillate, the ultimate branchlets in groups of 2–4, hyaline or subhyaline, and scabrid or minutely geniculate at the conidial scars. The conidia are produced singly at the scar, but as these latter are closely crowded, the whole appearance is that of small heads of globose conidia.

68. **Atractium Tremae** Hansford, sp. n. *Maculae* brunneae, angulosae, cinerascentes, arescentes, 1–2 mm. diam. *Coremia* amphigena, dispersa vel 2—3-fasciculata, erecta, recta, simplicia, dilute brunnea vel fulva, superne dilutiora, 300–500 μ longa et 30–70 μ diam., ex hyphis parallelis fulvis septatis 3–4 μ crassis superne divergentibus composita. *Conidia* terminalia, singula, filiformia, hyalina vel dilute flavida, 3—7-septata, haud constricta, levia, deorsum hilo plano praedita, apice attenuato-rotundata, 40–80 $\times$ 3·5–4·5 μ.

Hab. in foliis *Tremae guineensis*, Rifle Range, Kiagwe, Uganda, *Hansford 2698*.

The conidiophores are unbranched and divergent above ; the conidia are formed singly at the apex, which grows past the old scars to form other conidia, the upper part of the conidiophore becoming prominently geniculate at each scar.

69. Phaeodimeriella guarapiensis Speg. in Rev. Mus. La Plata, xv, p. 13 (1908). On *Hysterostomella Tetracerae* or *Tetracera potatoria*, Entebbe Road, Uganda, *Hansford 3152 p.p.*

70. Tolyposporium Penicillariae Bref. in Unters., xii, p. 154. On *Pennisetum spicatum*, Kitgum, Uganda, *Hansford 3085*.

71. Tolyposporium filiferum Busse in Arb. Biol. Abt. K. Gesundh. Berlin, iv, p. 2 (1904). On *Sorghum* sp., Karamoja, Uganda, *Hansford 2718*, leg. *A. S. Thomas*.

THREE ADDITIONAL RECORDS OF AFRICAN FUNGI.

By C. G. Hansford, M.A., F.L.S.

Senior Plant Pathologist, Uganda Department of Agriculture.

Meliola subdentata Pat. in Journ. de Bot., xi, p. 347, 1897.

On *Sansevieria* sp., Bambesa, Congo Belge, *Hendricks, 737, 740*.

Nectria meliopsicola P. Henn. in Pilze Ost-Afr., p. 32, 1895. On *Meliola Excoecariae* on *Sapium Simii*, Buccleuch, Natal, South Africa, *Doidge 11560*.

Periconia Doidgeae Hansford, sp. n.

Mycelium in plagulis *Asterinae* parasiticum, ex hyphis dilute olivaceis vel subhyalinis 2–3 μ crassis indistincte septatis ramosis compositum. *Conidiophora* dispersa, erecta, opace atrobrunnea, septata, recta, usque ad 240 μ longa et 7–10 μ crassa, superne leniter attenuata, apice capitem conidiorum efformantia usque ad 40 μ diam., globosum atro-brunneum. *Conidia* indistincte catenulata, ovata vel globosa, olivacea, continua, levia, usque ad 8 $\times$ 5 μ.

Hab. in plagulis *Asterinae* in foliis *Eugeniae Gerrardii*, *Doidge 17756* in Herb. Pretoria.

PROCEEDINGS OF THE GENERAL MEETING
23 March 1944

held jointly with The Zoological Society of London

Mr. A. D. Cotton, O.B.E., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 9 March 1944, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last meeting :—Mr. D. M. Reid, Mr. Jan Killander (Swedish Legation), Professor F. E. Weiss and the Carnegie Institution of Washington.

In accordance with Chap. 10, Sect. 8 of the Bye-Laws. the following Fellows were elected, by show of hands, as Auditors of the Treasurer's accounts for 1943–44 :—

Representing the Council : Mr. J. E. Dandy and Dr. N. A. Mackintosh.
Representing the Fellows : Mr. D. J. Scourfield, I.S.O., and Miss E. M. Wakefield.

The President reported the death of Sir David Prain, C.M.G., C.I.E., R.N.O., F.R.S., F.L.S., and moved the following resolution, which was passed in silence, all standing :—

> The Fellows of The Linnean Society of London in general meeting assembled having heard with deep sorrow of the death of Lieut.-Col. Sir David Prain, C.M.G., C.I.E., R.N.O., F.R.S., desire to place upon record their high appreciation of the services he has rendered to the Society during the fifty-six years of his Fellowship.
>
> Elected in 1888, he served on the Council from 1906 to 1910 and 1916 to 1919. He was appointed Vice-President on four occasions and held the office of President from 1916 to 1919. Throughout his Fellowship of the Society he showed the greatest interest in its work, by frequent attendance at its meetings, by important communications and by benefiting the Society by wise counsel derived both from his wide experience as an administrator and his attainments as a man of science and a humanist.
>
> Deploring the loss of so distinguished a Fellow, the Society desires to express to his relatives its deep sympathy with them in their bereavement.

The meeting held a discussion on the "Differences in observance between Zoological and Botanical Nomenclature".

Mrs. M. L. Sprague presented the case for the Botanists ; Mr. Francis Hemming, C.M.G., presented the case for the Zoologists ; and the following also took part :—Mr. A. J. Wilmott, Dr. E. Trewavas, Dr. T. A. Sprague, Dr. S. A. Neave, Dr. Malcolm Smith, Dr. J. Ramsbottom and the President. Mr. P. L. de Laszlo, Barrister-at-Law, summed up.

A DISCUSSION ON THE DIFFERENCES IN OBSERVANCE BETWEEN ZOOLOGICAL AND BOTANICAL NOMENCLATURE.

1. The Case for the Botanists.

By M. L. Sprague (M. L. Green).

The International Rules of Botanical Nomenclature as we have them today are the results of long deliberations and various international botanical congresses. Linnaeus himself in his ' Fundamenta Botanica ' and ' Philosophia Botanica ' laid down various principles for the guidance of botanists. Later these were followed by the famous ' Lois de la Nomenclature Botanique ' of Alphonse de Candolle, which were adopted by a Botanical Congress held in Paris in 1867. They contained 68 Articles (including Rules and Recommendations) and proved an excellent foundation for future nomenclature.

De Candolle's ' Lois ' did not meet with universal acceptance. Many botanists did not accept the principle of priority to the full extent. The publication of the ' Index Kewensis ' (1893–5) drew attention to many early generic names which had been neglected in favour of later ones. In 1891–3 Otto Kuntze, who had access to the manuscript of the ' Index Kewensis ', showed that in order to comply strictly with the principle of priority, it was necessary to change the names of over 30,000 species, which he proceeded to do. This led to a great split in botanical opinion between those who followed the rule of priority strictly, and those who considered it desirable to suspend the rule where its strict application led to undesirable changes in well known generic names.

The next Congress, known as the First International Botanical Congress, was held in Paris in 1900. At this, the ' Lois ' were discussed, and a decision was made to revise them at the Second Congress, held in Vienna in 1905. Here many changes were introduced, but the rule of priority was retained, except that the principle of *Nomina conservanda* was adopted, whereby certain generic names were placed on a list known as ' Nomina Generica Conservanda ', and were to be retained as exceptions to the rule of priority. This list included about 400 names of large or well-known genera which had to be used in preference to earlier and little known names, such as :—

Wisteria instead of *Kraunhia*,
Myristica (the nutmeg) instead of *Comacum*,
Sequoia instead of *Steinhauera*.

However, at Vienna complete agreement was not achieved : a number of American botanists rejected conservation and chose to follow the so-called American Code of Botanical Nomenclature.

The Third Congress, held in Brussels in 1910, mainly dealt with points not settled in Vienna.

The Fourth Congress was due to take place in London in 1915, but the last war prevented this, and it was held in 1926 at Ithaca, in the United States. As European representation was rather scanty at this

Congress, it forewent the right of legislation and occupied itself with lengthy nomenclatural discussions, and in appointing a Committee to report to the Fifth Congress at Cambridge in 1930.

Thus from 1905 to 1930 the Rules were given a good trial, even though a number of botanists followed the American Code rather than the International Rules.

At Cambridge, in 1930, the International Rules were modified so as to include certain good points from the American Code, while retaining *nomina conservanda*. Great efforts were expended in reaching this happy result, there was much give and take, and botanists the world over would be extremely loth to throw the Rules into the melting-pot again, thus imperilling their hard-won unity.

The results of the 1930 Congress are embodied in the third and latest edition of the 'International Rules', published in 1935.

A sixth botanical congress was held at Amsterdam in 1935, but no big changes in the Rules were made.

Such, then, is a very brief and very incomplete history of the International Rules, but it is sufficient to show that the passage has not always been smooth. For over a century there had been divergence of practice, one set of botanists going one way and another set another way.

The Rules of Botanical and Zoological Nomenclature are not ends in themselves: they exist for the *convenience* of botanists and zoologists, so that all may agree as to what name should be given to a particular group of plants or animals, after agreement has been reached as to its classification. Perhaps if both botanists and zoologists were starting from scratch the ideal might be one set of nomenclature rules for both sciences. But during the past century the general practice of botanists and that of zoologists have gradually diverged more and more, and the botanical rules, and presumably the zoological ones also, have been based on the best, that is, the most convenient, current practice. The rules of botanical nomenclature have evolved along with the evolution of botanical classification. Differences in classification between the two sciences entail differences in nomenclature. New discoveries, such as the existence of polyploid series within a single species, demand new provisions in nomenclature.

It may be doubted whether a single biological code would now be convenient either for botanists or zoologists. The advantages of having a single code would appear to be confined to the very small number of persons who are both botanists and zoologists, and to the editors of journals, such as the Linnean publications, which include contributions from both sciences.

The view just expressed is embodied in Art. 6 of the Botanical Rules and Art. 1 of the Zoological ones, which declare the independence of botanical and zoological nomenclature, while making provision for the transference of an organism from one kingdom to the other.

This independence results in a certain number of generic names being used by botanists for plants and by zoologists, for animals. This seems to have caused remarkably little inconvenience, at least to professional botanists and zoologists, perhaps because there is a tendency nowadays

to work in more or less water-tight compartments. To take a few examples :—

Iris (Iridaceae) and *Iris* (Orthoptera).
Fritillaria (Liliaceae and Lepidoptera).
Actaea (Ranunculaceae and Crustacea).
Dracunculus (Araceae and Vermes).

The context generally shows whether a plant or an animal is concerned, but a species of *Iris* (Orthoptera) might quite easily be included with species of *Iris* (Iridaceae) in an index.

All that can be hoped for in the direction of uniformity is a slight approximation in the two sets of Rules, embodying changes in either that seem desirable *on their intrinsic merits*.

In enumerating the chief differences in the two Codes, I may perhaps be allowed to indicate where, in my opinion, uniformity might be obtained.

One striking difference between botanical and zoological classification is the relative stability of botanical genera and the relative fluidity of zoological ones. In botany, genera and subgenera are sharply distinguished categories, and their names are not interchangeable. Many botanical genera have no subdivisions at all, or they may be divided into sections, subsections or series. In comparatively few are subgenera recognized. The emphasis is laid on the *genus*. On the whole, there seems to have been greater agreement among botanists as to generic limits than among zoologists, though a certain school of United States systematists have gone in for extensive splitting of genera during the past fifty years or so. Similarly, splitting has taken place in *Mesembryanthemum* by botanists of other countries, but comparatively few of the new segregate genera were previously recognized as subgenera.

In zoology there is no hard-and-fast line between genera and subgenera, and it is convenient to treat generic and subgeneric names as interchangeable.

Similarly species are relatively stable in botany and fluid in zoology. Hence names of species and subspecies are distinct in botany and interchangeable in zoology.

To obtain nomenclatural uniformity the taxonomic practice of either botanists or zoologists would have to be altered. The basic difference here is one of *classification* which is, perhaps, outside the scope of this meeting.

Accordingly, I maintain that in these instances no modification of either set of Rules should be considered.

This difference in classification leads on to one of the most important and far-reaching differences between the two sets of Rules, namely, the different conception of specific homonyms.

What is a homonym ? The botanical rule reads : ' A name of a taxonomic group is illegitimate and must be rejected if it is a later homonym, that is, it if duplicates a name previously and validly published for a group of the same rank based on a different type. . . .'

The zoological definition of homonym is : ' One and the same name for two or more different things '.

Homonyms may be generic or specific, or, indeed, names of any rank.

The zoological rule dealing with generic homonyms reads : ' A generic

name is to be rejected as a homonym when it has previously been used for some other genus of animals '. Also a similar rule with regard to specific names : ' A specific name is to be rejected as a homonym when it has previously been used for some other species or subspecies of the same genus '.

From reading these rules the differences between botanical and zoological homonyms are perhaps not very apparent, but there are big differences in their application, with regard not to generic homonyms, but to specific homonyms. Undoubtedly botanists find it difficult to understand the zoological rule concerning specific homonyms, and, maybe, zoologists have a similar difficulty in understanding botanical homonyms.

Botanical practice lays stress on the *binary name* of the species.

Zoological practice lays stress on the '*trivial*' (in botany spoken of as the specific epithet).

This difference is reflected in differences of terminology used in the botanical and zoological rules. In everyday language the word name is used in two different senses. It is equally correct to say that the name of the first President of the Linnean Society was Smith, or that it was James Edward Smith. His complete name, James Edward Smith, is composed of three names, a surname Smith, and two christian names, James and Edward. In botany the complete name of a species is termed the *name*, e.g. *Rosa canina*.

In the zoological Rules the complete name is termed the *designation*, i.e. the generic name plus the trivial, e.g. *Ursus arctos*.

When two species bearing the same trivial have been placed under the same generic name, in botany the earlier *combination* stands, and the later combination is rejected as a later homonym. In zoology the respective *dates of the two combinations* are immaterial : it is the combination including the *earlier trivial*, which stands, even if that combination was published after the combination containing the later trivial.

An example will serve to make this point clearer. The following six names have been given to the Silver Fir :—

Pinus Picea Linn. (1753).
Abies alba Mill. (1768).
Pinus pectinata Lam. (1778).
Abies pectinata (Lam.) Lam. et DC. (1805) ; not of Gilib. (1792), nor of Poiret (1804).
Abies Picea (Linn.) Bluff & Fingerh. (1825) ; not of Miller (1768).
Abies excelsa Link (1827).

The Silver Fir is now placed in the genus *Abies*. Taking the specific epithets (trivials) in chronological order, the binary name *Abies Picea* (Linn.) Bluff & Fingerh. (1825), cannot be adopted, because it is a later homonym, being antedated by *Abies Picea* Mill. (1768). Hence the name *Abies alba* Mill. (1768) is adopted for the Silver Fir. Miller could not adopt the earliest specific epithet *Picea* for the Silver Fir, since he used the name *Abies Picea* for the Spruce.

Under zoological Rules (if the Silver Fir had been an animal) the name *Abies Picea* (Linn. 1753) Bluff & Fingerh. (1825) would have been adopted. *The previously published* combination, *Abies Picea* Mill., is treated as the *later* homonym, which seems strange to botanists. Under zoological

Rules the fact that the trivial *Picea* Linn. (1753) antedated the trivial *Picea* Mill. (1768) is decisive.

Thus in botany stress is laid on priority of the binary name, and in zoology stress is laid on priority of the trivial.

This different conception of specific homonyms corresponds to the difference in the stability of genera in botany and zoology.

Consequently no alteration in either set of Rules is recommended.

Another point of difference in the two sets of Rules concerns the *Starting-points* of nomenclature.

In zoology, the starting-point for all groups is Linné, 'Systema Naturae', 1758.

In botany there are eight different starting-points for various groups of recent plants (recent as opposed to fossil), and a ninth for fossil plants. These starting-points cover the period 1753 (Linn., Sp. Pl., ed. 1) to 1900, and they have been adopted by botanists as the most convenient works and dates for the groups concerned, and at this late stage it would be well-nigh impossible to alter them and to try and fix one starting-point for all groups.

Therefore no change here in either set of Rules is recommended.

A further point of difference is that :—

In zoology the oldest available name is retained when an animal exhibits a regular succession of dissimilar generations which have been considered as belonging to different species or even to different genera.

In botany, among Fungi with a pleomorphic life-cycle, the accepted name is the earliest that has been given to the so-called perfect form. Generic and specific names given to other states have only a temporary value.

In fossil botany the valid name for any reconstructed plant is the first name given to any *combination of organs* ; the fact that any *isolated part* of the same plant had an earlier name is immaterial.

It is doubtful whether Mycologists or Paleobotanists would be willing to alter these provisions, but they can speak for themselves.

The next point of difference concerns the different endings of Family and Subfamily names in the two sciences :

In botany Family names end in -aceae.
Subfamily ,, ,, -oïdeae.
In zoology Family ,, ,, -idae.
Subfamily ,, ,, -inae.

This is perhaps not a very important point of difference, but as the endings are at the present time, they are certainly useful in indicating whether the group concerned belongs to the vegetable or animal kingdom.

And so here again I suggest no change in the Rules.

Lest by this time you will have come to the conclusion that I am a die-hard, I will now turn to some points in the Rules that I think might be modified, so as to bring about greater uniformity in the two sets.

First I propose to deal with *Nomina Conservanda*. Here I crave the indulgence of the zoologists, to whom, I understand, the term *nomina conservanda* is somewhat of a red rag. I believe they prefer to say 'The Rule of Priority is suspended in such and such a case'. I use the term merely as a matter of convenience.

Botanists have conserved names of Families (at present only those families which have the same names in Bentham & Hooker, 'Genera Plantarum', and Engler & Gilg's 'Syllabus' (1924). They have also long lists of *nomina generica conservanda*.

More than once the proposal to have *nomina specifica conservanad* has come before members of botanical congresses, but each time it has been defeated; on the last occasion at Amsterdam, in 1935, the proposal was defeated by 208 votes against 61.

Zoologists have lists of *nomina generica conservanda*, and, I understand from Mr. Hemming, certain specific names will be placed on the list before very long.

In this case I would recommend no change in the botanical Rules, but perhaps the zoologists would like to follow the botanists by placing Family names on their list.

Next let us consider the question of *tautonyms*, which are dealt with differently in the two sets of Rules. A tautonym is a combination in which the trivial merely repeats the generic name, e.g., *Linaria Linaria*.

The zoological Rules allow the use of tautonyms, the botanical Rules do not.

In 1930 a proposal was put forward to the Cambridge Botanical Congress to allow the use of tautonyms, but it was defeated. Before that congress I was privileged in being sent to visit a number of botanical gardens and universities on the Continent, to try to ascertain what views botanists held with regard to the nomenclature proposals for the forthcoming congress. I was impressed by the general dislike of tautonyms: one well-known professor declared he could not possibly vote in favour of them, as if they were admitted he could not keep order in his classes, his students always laughed when tautonyms were used. And I gathered this was the case in other universities on the Continent: it certainly was the reason for the rejection of a similar proposal in 1905 at Vienna.

This leads one to think that zoologists and botanists have a different sense of humour.

As against this possible drawback to the use of tautonyms, there are many points in favour of them. What is certain is that the rejection of tautonyms under the botanical Rules has, in conjunction with the rejection of epithets published in illegitimate combinations (illegitimate names), raised a whole series of awkward problems in the nomenclature of species. The acceptance of tautonyms would keep the original trivial, and serve a useful purpose in showing that the species concerned were the *types* of generic names.

Take the common yellow toad-flax, *Linaria vulgaris* Mill. How is anyone to know, without consulting a list of its synonyms, that this species was first published as *Antirrhinum Linaria* Linn., Sp. Pl., ed. 1 (1753), and that it is the type species of *Linaria* (although this might perhaps be guessed from the epithet *vulgaris*) ?

But if we adopt the name *Linaria Linaria* (Linn.), both points become clear.

I think, therefore, that botanists would do well to reconsider their decision, and, like the zoologists, admit the use of tautonyms.

In dealing with tautonyms I mentioned the rejection of epithets

published in illegitimate combinations (illegitimate names). This, I think, is a real bugbear to botanists, and needs some explanation.

The International Rules of Botanical Nomenclature, as adopted in Vienna in 1905 and enlarged in Brussels in 1910, largely reflected the views of the Belgian-Swiss bloc of botanists. The Rules were framed on the analogy of a civil or criminal code of laws, and included a retroactive provision, preventing the author of a specific name which infringed the Rules from gaining any advantage thereby. It was decided that the offending specific epithets should not rank for purposes of priority. Such epithets are apparently not necessarily rejected in zoology.

This penalty may be useful in deterring individual botanists from proposing names contrary to the Rules in the future, but it has resulted in very great inconvenience to all botanists at the present day. It often happens that when the first epithet given to a species is unusable, because its adoption would result in the creation of a later homonym or tautonym, the next earliest epithet has also to be rejected because it was published as part of an illegitimate binary name.

The search for the earliest legitimate epithet is then often a very troublesome business, and, when found, it may be an epithet originally applied to some aberrant form of the species, as, for example, *Calamagrostis canescens*, which replaces the tautonym *Calamagrostis Calamagrostis* and the illegitimate name *C. vulgaris*.

It is, to say the least, unfortunate to have to accept a specific name whose type is an aberrant form of the species.

If the Rule concerning the rejection of epithets of illegitimate combinations were altered, I feel convinced it would make for smoother working and save an enormous amount of time.

A further point of difference between the two sets of Rules deals with the question of Latin diagnoses for new groups of plants.

In botany the publication of the name of a new group of recent plants (Bacteria excepted) is not valid unless a Latin diagnosis is supplied.

In zoology there is merely a recommendation that new groups should be accompanied by diagnoses in English, French, German, Italian or Latin.

This question of the compulsory Latin diagnosis or Latin description of new groups of plants has been a bone of contention in many botanical congresses. As soon as the suggestion of dropping compulsory Latin was made, and various other languages allowed to be used instead, members of all nationalities present wanted their languages to be included.

Obviously, the publication of large numbers of new groups of plants in little-known or difficult languages, especially such as are not written in roman characters, would seriously retard taxonomic work.

The botanical rule, therefore, insisting on the Latin diagnosis seems preferable, and this is a case, I think, where zoologists might come into line with the botanists.

Lastly, I propose to deal with the decapitalization of trivials.

In botany, decapitalization, or otherwise, is dealt with by a recommendation and not by a rule. In zoology it is dealt with by a rule which reads: 'All trivial names must be written with a small initial letter except substantive names derived from names of persons, which may be written with a capital.'

The botanical Rules recommend that capital initials should be employed for all epithets derived from names of persons, or taken from generic or vernacular names, and that all other epithets should be written with a small initial letter.

The reason why this is embodied in a recommendation rather than a rule is that some botanists might find it difficult, either through lack of knowledge or through lack of library facilities, to ascertain whether the epithet is derived from a personal name, or is a generic or vernacular name ; such botanists are free to decapitalize in all cases.

If the recommendation is followed, the results are certainly helpful, the capitals in such names as *Schinus Molle* and *Liriodendron Tulipifera* show at a glance that the specific epithets are either vernacular (Molle) or generic (Tulipifera) names, and that they are not adjectives with the wrong genders.

However, this is perhaps a case where complete uniformity in the two sets of Rules might be achieved, if both botanists and zoologists agree to decapitalize in all cases.

The following are some minor differences in the two sets of Rules :—

In botany the trivials of homonyms may be used again for the same species under another generic name, provided that there is no validly published trivial available.

In zoology the trivials of homonyms cannot be used again for the same species.

Here the zoological rule seems preferable, as difficulties have arisen as to the application of the botanical rule.

In botany, in formulae for hybrids, the female parent is cited first, and fractional formulae are not used.

In zoology, in formulae for hybrids, the male parent is cited first, and fractional formulae (male as numerator, and female as denominator) may be used.

No change recommended.

In botany, names of families are formed from generic names, but nine names not so formed are admitted as exceptions :—*Palmae*, *Gramineae*, *Cruciferae*, *Leguminosae*, *Guttiferae*, *Umbelliferae*, *Labiatae*, *Compositae*, and *Papilionaceae* (if regarded as an independent family). Names of families may be formed from a generic synonym, e.g. *Nyctaginaceae* from *Nyctago* (a synonym of *Mirabilis*).

In zoology, names of all families are formed from the accepted name of the type genus.

No change recommended.

Authors of botanical names derived from languages in which the Latin alphabet is used are not bound to retain the exact original spelling ; diacritic signs should be suppressed.

In forming zoological names derived from languages in which the Latin alphabet is used, the exact original spelling, including diacritic marks, is to be retained.

No change recommended.

In botany, specific epithets such as *sinensis* and *chinensis* are treated as orthographic variants of the same word, though *sinicus* would probably be regarded as a different word.

In zoology, two or more adjectives derived from the radical of a geographical name and used as trivials are treated as different words, e.g., *sinensis*, *sinicus* and *chinensis*.

The botanical rule seems preferable.

2. The Case for the Zoologists.

By Francis Hemming, C.M.G., C.B.E.
(Secretary to the International Commission on Zoological Nomenclature).

Unlike botanical nomenclature, which has eight different starting-points, each applicable to a particular division of the Vegetable Kingdom, zoological nomenclature starts for all branches of the Animal Kingdom from the publication in 1758 of the 10th edition of Linnaeus's 'Systema Naturae'. As in the case of botanical nomenclature, there were at the outset no rules governing zoological nomenclature, though from the earliest times most authors accepted the principle of the Law of Priority. This acceptance was, however, far from being universal; for long, authors felt themselves free to reject or change names on the ground of inappropriateness; there was great variety in the treatment of specific trivial names that were homonyms; tautonymy was commonly regarded as a valid ground for the rejection of names. Further, for the first seventy or eighty years (till 1840), there was no general recognition of the need for fixing a type for each genus, and in consequence there was the greatest confusion in the use of generic names in many branches of the Animal Kingdom.

The first attempt to formulate a set of rules for zoological nomenclature was made in 1842–3, when the so-called 'Strickland Rules' were drawn up by a committee of which Charles Darwin was a member. These rules were adopted in 1843 by the American Society of Geologists and Naturalists, and in 1846 by the British Association for the Advancement of Science. These rules did something to improve matters, but the great increase in the number of genera and species described in the following decades made it abundantly clear that more detailed rules, backed by international authority, were essential if the constantly increasing mass of zoological names were to be reduced to any kind of order. Accordingly, an attempt to secure agreement upon a set of International Rules was made at the First International Congress of Zoology held in Paris in 1889. In view of the both complicated and controversial nature of the task it is not surprising that neither at the Paris Congress nor at its successor, held in Moscow in 1892, was it possible to make any substantial progress.

This question was considered again at the Third International Congress of Zoology, held at Leyden in 1895, when the Congress accepted a proposal made by the German zoologists that a special Commission of five members should be charged with the duty of (i) studying the various unofficial codes then in use, and (ii) of making recommendations to the next Congress. This Commission met at Baden-Baden in 1897 and reached a substantial measure of agreement, but on various important points failed to secure unanimity. When the Fourth International Congress of Zoology met at Cambridge, in 1898, the Commission was not permitted by the authorities of the Congress to bring forward their report on the

ground that it was not unanimous. The Commission, which was thereupon enlarged to consist of fifteen members, was directed to continue its studies with a view to submitting a unanimous report to the next meeting of the Congress at Berlin in 1901. By the time of the Berlin meeting, agreement had been reached in the Commission on most of the outstanding matters, but complete unanimity on all points had not been achieved. The authorities of the Berlin Congress took the same line as their predecessors at Cambridge and informed the Commission that, unless the Commission could submit a unanimous report, it would not be possible for a day to be found for the presentation of their report to the Congress. Faced with this second rebuff, the Commission held further meetings at which, by a process of give and take, unanimity was at length secured. The Commission were then allowed to present their report to the Congress, which approved the Code recommended (subject to various amendments). A special committee, under the chairmanship of Professor R. Blanchard of Paris, was appointed to prepare for publication the authoritative French text of the Code that had been adopted, together with official English and German translations. This Committee met at Berne in 1904 and the result of their labours was published in the spring of 1905.

The chief difficulty at Berlin had centred around the application of the Law of Priority, and as the result of the compromises that had then been necessary to secure unanimity, the provisions in the Code on this subject were considerably more rigorous than had been originally proposed. In the hope of showing that, as regards many important names, the strict application of the Law of Priority (as laid down in the Code) would not have the effect of disturbing existing practice, the Congress at Graz in 1910 approved a proposal submitted by the International Commission that there should be established an 'Official List of Generic Names', on which should be placed the 5,000 to 10,000 best-known generic names in zoology, with their type species. The establishment of this 'Official List' did nothing, however, to meet the case of the generic names which, though in universal use for well-known groups, were either themselves invalid or were associated with species that were not their types under the rules embodied in the Code. So strong did feeling run on this subject, both among those who urged that some relief should be granted in such cases and among those who stood for the unqualified acceptance of the Law of Priority in all circumstances, that there was, at this time, a real danger of a split between the two schools of thought, and consequently a risk that the International Code, secured with such difficulties ten years earlier, might collapse. In these circumstances, the Ninth International Congress of Zoology, which met at Monaco in 1913, decided upon a compromise which was accepted by both sides; the Law of Priority was to be maintained in its full rigour, but the International Commission was to have power to suspend the rules as applied to any given case where, in the judgement of the Commission, the strict application of the rules would clearly result in greater confusion than uniformity. The grant of this power was hedged in with a number of safeguards to secure that it was only used in the most glaring cases, the most rigorous of the conditions so imposed being the requirement that (save in certain exceptional circumstances, to

meet which express provision was made) the power to suspend the rules should only be exercised by the Commission when all the Commissioners voting were unanimously in favour of that course.

In the forty-three years that have elapsed since the adoption of the Code at Berlin, in 1901, only five substantive amendments have been made in it by way either of additional provisions or of changes in existing provisions. This remarkable stability has been largely due to a desire on the part of all concerned to avoid the dangers which would inevitably arise if old controversies were revived through throwing the whole subject open to discussion. In part, however, the stability of the Code has been assured through the grant to the International Commission at Boston, in 1907, of the duty of rendering 'Opinions' on questions of interpretation arising from the application of the Code to particular cases. The 'Opinions' so rendered have to be reported by the International Commission to the next meeting of the International Congress of Zoology, but they become operative immediately upon publication and do not require the approval of the Congress. On all matters of interpretation, the International Commission has, therefore, a judicial function, and the 'Opinions' which it renders are as binding as any of the provisions embodied in the Code. The method of proceeding by the issue of an 'Opinion' rather than by making formal additions to the Code has many advantages; in particular, it secures that full consideration is given to all aspects of any given question before a decision is taken thereon; ample opportunity is provided to zoologists to express their views while the proposal is still under consideration; all risk is avoided of hasty and ill-judged changes being introduced into the Code by a chance local majority at a particular meeting of the International Congress of Zoology. This latter consideration is of the greatest importance, since, owing to the length of the journey involved for many zoologists, the cost of travel and, in some cases, restrictions imposed upon travelling, the International Congress is not well equipped for taking decisions on controversial questions. Zoologists of the country in which the Congress is held are naturally strongly represented, and so are those from neighbouring countries, but usually the contingent of zoologists from the more distant countries is relatively small. Hence, any decision on a question involving controversial issues taken in such circumstances might easily lead to serious difficulties. On at least one such occasion difficulties of this kind actually arose, and the International Commission are now studying proposals designed to provide machinery by which, when it is necessary to amend the Code, the necessary action can be taken in a genuinely representative manner.

Mrs. Sprague in her address has drawn attention to the chief differences between the botanical and zoological Codes. Those differences are very substantial, more so, indeed, than they appear at first sight. In particular, the botanical rule by which generic and subgeneric names are independent of one another instead of being co-ordinate, as in zoological nomenclature, would, if applied to zoology, produce the most devastating changes in current practice. Similarly, as regards specific (and subspecific) trivial names, the botanical rule that such a name takes priority as from the date on which it was first used in combination

with a given generic name, instead of from the date upon which that trivial name was first published in combination with any generic name (as is the rule in zoological nomenclature) would, if applied in zoology, lead to the rejection of an enormous number of names now in universal use. Further, the rules in the botanical Code relating to 'illegitimate names' and to the rejection of tautonyms would displace large numbers of names now in use if these rules were to be applied to zoological nomenclature.

As an experiment, I recently took a well-known group in the Order Lepidoptera and tried to apply to that group the rules laid down in the botanical Code. For this purpose, the group chosen was particularly suitable, for it abounds with examples of each of the various classes of name discussed above. I have to confess that, when the experiment had been concluded, the nomenclature of this group had suffered such extensive and surprising changes that many specialists would have been hard put to it to recognize even some of the most familiar species. No doubt equally surprising results could readily be obtained by any botanist who might think it worth while to revise some familiar group of plants in accordance, not with the botanical Code, but with the zoological Code.

Clearly, if there was to be any attempt to establish a combined Code for botany and zoology, each side would have to give up some of its cherished provisions. The result for both at the outset would be great confusion resulting from the rejection of many well-known names. The uniformity so secured between botany and zoology would, in my judgement, not be worth the difficulties involved, in view especially of the fact that, owing to specialization, very few Societies, journals or individual workers concern themselves seriously both with botanical and zoological studies.

Quite apart from these general objections, any attempt to draw up a combined Code would, from the zoological standpoint, be most injudicious and ill-advised. The present International Code of Zoological Nomenclature has only been secured at the cost of infinite labour and with the help of numerous compromises and understandings (in the nature of 'Gentleman's Agreements') between zoologists of opposing schools of thought. To throw away all this labour and risk reopening the compromises that have been reached and breaking the understandings that have been entered into would represent an altogether excessive price to pay for the mainly theoretical advantage of securing uniformity of practice between zoologists and botanists. Judging by the difficulties which, as Mrs. Sprague has explained, attended the adoption of the International Code of Botanical Nomenclature, it is reasonable to conclude that powerful objections of a similar kind would arise if any attempt were made to introduce radical changes in botanical nomenclature for the sake of securing a joint botanical-zoological code.

Zoologists and botanists have, no doubt, much of value to learn from one another in matters of nomenclature, and joint consultations for this purpose should be fostered wherever possible, particularly when occasion arises to consider the application to nomenclature of new taxonomic concepts. For this purpose there is, however, no need for a joint zoological-botanical Code.

3. A criticism by Mr. A. J. Wilmott.

The differences between zoological and botanical nomenclature are a little less than they were before the revision of the Botanical Rules which followed the ' Proposals by British Botanists ' which were sent forward to the International Congress in Cambridge, 1930, from the Imperial Botanical Congress in London some years earlier. As one of the Committee primarily concerned with the preparation of these ' Proposals ', I studied the zoological Rules with a view to discovering what of value in them could be incorporated into the botanical Rules. The present difference between the two sets of Rules as regards the citation of the author of a name—single in zoology but in botany double after recombination of the epithet—was regarded by me purely as a transitional state in botany, necessary as a step towards the zoological method (or something like it—for I regard the citation of author as essentially of the nature of an abbreviated reference, and think that the original form of publication of the epithet should always be indicated), such a transitional state being necessary to obtain acceptance in botany of the citation of the author on whom the type depends, and imperative in view of the introduction then into botanical nomenclature of the type-method for obtaining precision in application of name. The second citation—second author—is, in my view, taxonomy, and definitely *not* nomenclature, and although not without a certain taxonomic and bibliographical value, only pernicious in its nomenclatural results. Unfortunately the last Botanical Congress did not view matters in that way, and has, in my opinion, thrown a spanner into the works which may create considerable trouble before it is removed. But this is rather by the way.

My concern this afternoon is not, however, to emphasize the differences, but to consider the similarities between the two sets of Rules, and how they can be increased. For the materials with which the two Codes are concerned are fundamentally identical; i.e. the real natures and functions of names, descriptions, figures, types and other specimens, even often species, etc., are definite things. Each of them can do certain things, but not others: with each of them certain things can be done, but not others. And they are identical in both sciences, except that there are probably different kinds of species which may need separate treatment. But botany alone has to deal with different kinds of species, so that fact does not provide any insuperable obstacle to the formulation of a Code of Nomenclature which would cover both sciences and be uniform so far as possible. One would have thought that since what I have called the ' materials ' of nomenclature are the same in both sciences, the Rules of Nomenclature would have been almost identical. Certainly they should be identical so far as the fundamental natures and functions of these ' materials ' are concerned.

The differences primarily arise from certain differences in practice which were at the time of little importance, and possibly are still so, except that to depart from the now established practice would, after nearly two centuries of customary usage, cause so much alteration of name that disservice would be done to the science concerned. For the primary service of Rules of Nomenclature is to provide some *permanent* set of names for entities which will permit the best possible indexing of the

known facts concerning these entities. Each time a name is changed the cataloguing and indexing is damaged, and the overlooking of essential information is made easier. Changes of name cannot be entirely eliminated, but the Rules should be such that these are minimized so far as can be done on any reasonable method with a scientific basis, whether by conservation or any other means. Too many nomenclators forget that this satisfactory indexing of information is the primary function of Rules of Nomenclature, and use the idea of priority, which was intended to serve and produce fixity, to produce change, as if priority itself was something of value instead of a mere tool.

The existence of such long-established diverse usages in botanical and zoological nomenclature will, therefore, probably make it impossible to arrive at a single set of Rules uniform for both sciences, but I see no reason why that fact should prevent the establishment of a set of Rules applicable to both. For just as in botanical nomenclature we have differences in Rules for fungi, and fossil plants, so it should be possible to draft a set of Rules which should deal adequately *and uniformly* with all fundamental matters concerned with the natures, functions and relations between names, species, types, descriptions and so on, and in each article of the Code to provide for any divergences necessary as a result of unessential divergent custom, by a series of paragraphs beginning: 'In botany . . . (so and so—or even 'In fungi . . ., In fossil plants, . . . In other plants . . .)' and 'In zoology . . . (so and so different)'. If this were done, the fundamentals of good nomenclature might be brought out more clearly, and differences might later seem to be so relatively unimportant that greater uniformity in rule and practice might gradually arise.

Theoretically I see no great obstacle to what I have just said. Practically there might be many difficulties, and from the remarks of the previous speakers it seems obvious that there would be! Some nomenclators are inclined to treat nomenclature as if it were a goddess instead of an old harpy, but apart from such often very real difficulties, it would be difficult to hold a combined International Congress of Botany and Zoology at which the problem could be discussed. But it might be possible to agree to the appointment of a Joint Committee which could try to formulate such a combined code of nomenclature as I have indicated, and its draft might be considered by botanical and zoological congresses separately.

For a really sound revision on these lines, taking account of both fundamentals *and* divergent custom, might be such an improvement on both present Codes that both sciences would benefit from its acceptance. A few generic names now used in both sciences would have to be replaced, but, anyway, is it not rather absurd to use one name for more than one kind of living organism? If time permits, I should like to make very brief comments on the chief differences.

I would emphasize that the most valuable improvement made in the botanical Rules in 1930 was probably that which restricted the use of the word *name* to a single connotation—a plant name—and adopted the words *epithet* and *term* for other connotations which had also been given to the word *name* with consequent destruction of clarity. The zoological Code is still in confusion from misuse of the word *name*.

There is no time to enlarge upon this, except to say that clear thinking produces a demand for right use of words.

The botanical attitude to homonyms is, I believe, correct. To take the illustration given by Mrs. Sprague, *Abies* is a *name*. A *name* is a *noun*, a *substantive* meaning something by itself. *Alba* is *not* a name, it does *not* mean anything by itself. If I say that '*alba* is a fine tree' who can say if I mean *Abies alba*, or *Quercus alba*, or some other tree? *Alba* is an *epithet*, i.e. a word which limits the connotation of a noun. When the British Sub-Committee already mentioned discussed this point, one member at first took the view that the so-called 'trivial name' —i.e. 'specific epithet'—was a name just as John and Mary were names. But I happened at that time to have living in my house my son John and the son John of some friends, and I had found by experience that John by itself meant nothing and was, therefore, not a substantive meaning something definite, for at first, when 'John' was called, both came, and later neither came, as each hoped he was the one not wanted. John and Mary are really only epithets. And (in botany at least) the Linnean 'trivial names' are really names, being names of old genera, substantive in nature and spelt with an initial capital letter, and not necessarily agreeing with the gender of the generic name.

The separation—in the zoological Code—of Recommendations from Rules, is very good. Their mingling in the botanical Code not only makes the recommendations difficult to find, but also leads to their being treated as if they were Rules. Some of them are even now generally used as if they were Rules and the applicable contrary Rule ignored: or there is no Rule at all in one instance, because at the last Congress a Rule was changed into a Recommendation, and no Rule at all substituted. For example, Mrs. Sprague cited as one of the differences from zoological nomenclature regulations for the use of initial capitals to some specific epithets. But there is actually no botanical Rule concerning this. There is a Recommendation, but the only Rule of which I am aware is that the original spelling is valid, and it will be found that Miller, in the eighth edition of the 'Gardeners' Dictionary', used initial capitals generally for his specific epithets, which must, I believe, according to the botanical Rules, be retained [e.g., *Limonium Humile* Miller. At the last Congress, I advocated the turning into Rules of the essentials of some of the Recommendations, in order to avoid the time-wasting work of checking every individual spelling, but the necessity for my proposition was not perceived.]

I am entirely in agreement with the zoological Code in refusing to deal with groups [miscalled there 'names'!] of lower rank than subspecies. My view is that the Code should be concerned only with the different *kinds* of plants (or animals), and that the variation needs entirely different treatment—and a special set of Rules, if necessary—because the entities concerned are of different nature. And I heartily subscribe to the view that genera and subgenera, species and subspecies should be treated as co-ordinate in nomenclature, i.e. of equal *nomenclatural* rank, although of different *taxonomic* status.

Botanical species have, in my opinion, just as many subspecies as animal species, but the category has been less used: that is all. In such a genus as *Hieracium*, where hundreds, if not thousands, of sub-

species have been named, specialists on the genus have, in fact, found it useful to adopt the zoological practice of treating the subspecies as co-ordinate with species for purposes of nomenclature, and have treated as homonyms later uses of the same epithet for a subspecies, no matter of what species.

Then I agree that only the so-called ' binomial ' nomenclature should be valid, and I have fought for this continuously. Botanists have to reject accidental biverbal specific names published after the starting date, but must accept the equally accidental univerbal generic names in the same non-binarist works. This course has been responsible for a great amount of name-changing since 1905, and the present botanical method seems to me merely silly.

As regards typification, no thoroughly good exposition of the fundamental principles concerned has been published, and it would be better that no set of rules for typification should be adopted until the natures and relations of types, names, definitions, descriptions, figures, specimens, protologues and the like have been thoroughly understood and the consequences generally accepted by the chief nomenclators.

The so-called ' tautonyms ' should be accepted by botanists. Zoologists have not found that zoology has become an ' object of ridicule ' through their use. And they are not tautonymous, nor is there any vain repetition about them, for the one word is a generic *name* and the other a specific *epithet*, and each word has its own meaning and distinct connotation. Further, the consequences of their rejection in botanical nomenclature are quite deplorable.

There are many other minor differences, in orthography and such things, but they are still hotly debated in both sciences, wherefore we might hope that uniformity might ultimately be reached for both.

And may we not hope that die-hards, even though they die hard, will die some day, and that a new generation may be able to bring a fresh outlook to these problems, free from ancient bias of any kind ?

4. Comments by Dr. Ethelwynn Trewavas.

I agree with those previous speakers who consider that uniformity between the two sciences is not, in itself, sufficient reason for changing either set of Rules of nomenclature.

I welcome Mr. Wilmott's criticism of the use in the zoological Rules of the term ' specific name ' when ' specific epithet ' is intended.

I hope that the time will soon be deemed ripe for a scrutiny of the Opinions interpreting the Rules, and of the Recommendations, to see whether the sense of some of them may not usefully be incorporated in the Rules. Contradictions within the Code might also be looked for. The spirit, for instance, of the Opinions interpreting Article 19 of the zoological Rules seems out of accord with that of the Recommendation appended to Article 36.

5. Comments by Dr. T. A. Sprague.

Dr. Sprague doubted whether it was now practicable, or even desirable, to have a single set of Rules of Biological Nomenclature ; but, as Secretary of the International Executive Committee of Botanical Nomenclature,

he undertook to transmit to that Committee—after the war—any resolution adopted by the Meeting or by the Linnean Society. In any case, it was certain that nothing but good could result from study by botanists and zoologists of each other's Rules.

He acknowledged the valuable service performed by Mr. Wilmott as a member of the British Sub-Committee on Botanical Nomenclature (1923–30) in suggesting more precise wording of the botanical Rules. Although they held different views on certain theoretical questions, they had usually been in agreement when some important practical point in nomenclature came up for decision, and the essential test of Rules lies in their application.

6. Comments by Dr. Sheffield Neave.

Dr. Sheffield Neave said that he had not expected to be called upon to speak on this important discussion, but would like to support the first two speakers in expressing the view that it would be both difficult and undesirable to attempt to combine the Rules of Nomenclature of zoology and botany. He strongly favoured, however, anything that would simplify these Rules and called attention to the difficulties that arise from the present ruling in zoology, that specific names in an adjectival form should follow the gender of the genus to which they are attached. This might have been feasible in the days of the classical tradition, but now seemed almost impossible to carry out in practice. Indeed, he was inclined to suggest that it might be of great advantage if one gender was adopted for all specific names in botany and the other for those in zoology.

In conclusion, speaking as Secretary of the Zoological Society of London, he wished to take the opportunity of thanking the Council and Fellows of the Linnean Society for the hospitality they had afforded to the Zoological Society in arranging for these joint scientific meetings.

7. A Summing-up by Mr. Paul de Laszlo.

Mr. de Laszlo thanked the President for the honour of being asked to sum up the discussion which had taken place. At the same time, he found his task more difficult than he had anticipated. In the sense in which he, as a barrister, understood the term 'sum up' there was no summing up for him to do. He had not that afternoon heard speeches in support of two conflicting points of view which would have enabled him to underline the arguments for and against the adoption by the zoologists or the botanists of modifications to either system of nomenclature. With the exception of one or two proposals made by Mrs. Sprague, the speakers, where they had touched on differences in the two systems had been unanimous in stressing that the differences should remain unchanged. Although there was thus no conflict, and no summing up that he could do, Mr. de Laszlo thought that he could perhaps best occupy the time allotted to him by stating how he, as an outsider, had reacted to the various points which had been raised.

There was first the general question of the nature and history of the respective Codes. Here again neither of them was a *code* in the sense that he, as a lawyer, understood the term. The nomenclatural problem which confronted biologists was not one of taxonomy. The system

was there; what was required was the labelling. Mrs. Sprague had put it aptly when she had said; 'The rules of botanical and zoological nomenclature are not ends in themselves: they exist for the convenience of botanists and zoologists, so that all may agree what name should be given to a particular group of plants or animals after agreement had been reached as to its classification'. The magnitude of the task could be seen in its true proportion when it was realized that in each kingdom the number of labels to be fixed was of the order of one million. That should be considered in comparison with the nomenclatural task of, say, the Post Office, which had over two million telephone numbers to allot, or the American Telegraph and Telephone Corporation, which had over thirty million. The painful struggle of the special Commission in the six years between 1895 and 1901 had been most entertainingly described by Mr. Hemming. If the sole aim of that struggle had been to create a nomenclatural code for zoologists, it would not have lasted for six years, nor would it have been a struggle. To work out a true Code with the object of assigning fixed labels to a million separate objects could not have been difficult, even where considerations of mnemonics and language had been present. Solutions such as the use of symbols, either letters or numbers, would have presented themselves, and a true nomenclatural code would have resulted. As it was, it was manifest that the Rules which existed today were a series of compromises with tradition and human frailties. They treated as much with etiquette as with nomenclature.

Mr. de Laszlo said that he realized he was being very critical, but that did not mean that he did not see the difficulties. These had been crystallized for him by Dr. Malcolm Smith, who quoted the saying that 'The law is an ass, but it can be enforced; the laws of nomenclature, although equally asinine, cannot be enforced'. He realized that, without sanctions, no set of international nomenclatural rules could ever be anything but compromises, and that to dwell on the ideal without considering the difficulties was fruitless. A clean sweep was out of the question; but that should not imply that wherever possible improvements should not be made, and what better way was there than for zoologists and botanists to learn from the experience of each other in the operation of their similar sets of Rules? Nearly every speaker had protested that he was not a die-hard, but at the same time nearly all, including the President, had rejected the idea of modification for fear of stirring up old troubles. Dr. Ramsbottom and Mr. Wilmott were in favour of a common set of Rules, but the former speaker had said that to tackle the problem required courage. In that respect Mr. de Laszlo said that he felt himself to be in a strong position, as he could easily advise others to sum up the necessary courage when he himself did not have to make that effort. That results could be achieved even though considerable change was involved was evidenced by the effort of Otto Kuntze, who had proposed to alter the names of 30,000 species in applying the Rules of 1867.

The speaker then said he would touch on the specific points which had been made.

Mrs. Sprague had referred to the interchangeability of names as between zoological genera and subgenera and between species and subspecies.

She had pointed out that in the zoological Rules a genus and subgenus were co-ordinate from a nomenclatural standpoint. This was not the case in botanical practice, and Mr. de Laszlo said that it appeared to him that if the zoological Rules aimed at internal consistency, each rank in the hierarchy should carry greater weight than the next lower step. The zoologists might well consider bringing the relevant articles into line with botanical Rules.

On the question of rejection of homonyms, Mrs. Sprague and Mr. Wilmott had both emphasized the merits of the botanical practice of treating the binary name as an indivisible unit. It was to be rejected only if an identical binary name had preoccupation. The zoologists, on the contrary, would reject the trivial name alone if that were preoccupied, even if it belonged to a different genus. Here Mr. de Laszlo thought that good sense lay on the side of the botanists. The designation of a man was neither his surname nor his Christian name, but the combination. So it was with a species ; either the label as a whole was homonymous or it was unique, and in his view it should be accepted or rejected on those grounds.

The difference between Article 2 of the botanical Rules which allowed eight different starting-points for priorities, and Article 26 of the zoological Rules, fixing 1758 as the sole starting-point, had been stressed. He thought that this distinction was unimportant and consistent with the compromise nature of both sides which he had referred to earlier.

Another difference to which reference had been made was that the botanical family and sub-family endings were respectively -aceae and -oideae, whereas in zoology they were -idae and -inae. Here no question of principle was involved : what were the merits ? If clarity was a desideratum, these differences were to be encouraged as they emphasized immediately which kingdom was in question. This was evidently an advantage, as Dr. Neave had even suggested that the difference should be underlined by assigning a different gender to each. In the circumstances it did not seem that the existing Articles should be disturbed.

Tautonymy seemed to present difficulty, both in its definition and application. The botanical Rule was clear. A specific name must not be assigned which had also been used for the genus to which the species belonged. He had not understood that any of the speakers had advanced logical reasons for the Rule, nor could he himself see that a name was objectionable because it was repetitive. Mrs. Sprague had stated that she had been told of a certain lecturer who found that tautonyms in the sense described had excited laughter among his pupils. Mr. de Laszlo thought that that was a poor reason in support of the Rule, and if it were of general application, he, as a barrister, would constantly be reduced to laughter by the names of many of his solicitor clients, who notoriously used repetitive names as the titles of their firms. In any event, he thought that laughter was a dangerous test to apply to biological nomenclatural rules, and he felt that the botanists might consider adopting the zoological practice of accepting tautonyms.

Astonishingly it had been stated by Mr. Hemming that a consideration which had influenced the Swiss delegation at the Berlin Conference to support the permanent rejection of superfluous botanical epithets was that it would in effect constitute a punitive measure. Surely this

exemplified the degree to which considerations of human nature had influenced the character of the Rules. The only consideration should be—does the Rule make for certainty, for clarity, and for fixity. It did not seem to help in any of these directions. The zoologists were right in having no such Rule.

Much had been said outside the Linnean Society for and against the use of Latin in all technics. Arguments both logical and specious were advanced by its supporters and antagonists, but he had come to the conclusion that the majority of either schools of thought held its view through prejudice and not logic. Having admittedly thus weakened his arguments in advance, he declared that he belonged to the anti-Latin camp. He was sorry to find that during the afternoon only Dr. Malcolm Smith had opposed the botanical article calling for Latin diagnoses. He understood that new diagnoses each year were of the order of one to two thousand. Why could not the biological societies in each country have these translated into their own tongues ? Would this be a greater burden to mankind than the compulsory learning of Latin by biologists, not only in countries where Latin formed a part of normal educational curriculum, but in such countries as Russia and China ? Was Latin the lingua franca in which discussions had been conducted at the various nomenclatural Congresses ? That Latin was not essential to international nomenclature was evidenced by, say, the great chemical firms, who between them applied for patents of new organic compounds in large numbers annually in every civilized country : fortunately he was not aware that there was a rule in any country that patent specifications had to be filed in Latin. .

The rules regarding the use of capital letters again showed a weakness towards personal vanity. Both zoologists and botanists supported capitals where patronymics were concerned. Perhaps the zoologists were less a party to this weakness, for by Article 70 it was laid down that whereas trivial names must be originated with a small letter, capitals might be used where the derivation was from a proper name. The botanists, on the other hand, specifically recommended by Article 70 of their Code that capitals should be employed in the case of patronymics. With Mrs. Sprague, Mr. de Laszlo was in favour of abolishing capitals in all cases.

Lastly, there was a question which was brought out by Mr. Wilmott and Dr. Trewavas. The system of Recommendations and Opinions made by the respective permanent Commissions was known to both classes of biologists. Mr. Wilmott considered that this system was satisfactory as it stood. Dr. Trewavas took the view that Rules should be framed to incorporate the positive elements which were to be found in these Recommendations and Opinions. Mr. de Laszlo, as a lawyer, found it impossible to disagree with Dr. Trewavas. Again, reverting to the law by way of analogy, he explained that as each new code of law was formulated by the legislature, the judges, by the opinions they expressed in court, expanded the law as it stood, and even, by committing themselves to expressions of opinion, pointed the way to the modification and improvement of the code. In course of time the codes were amended. In some cases, as in that of the Finance Acts, the revised codes were of frequent occurrence, as case law pointed the way to loopholes in the

existing Acts. So should it be with the rules of nomenclature. The Opinions and Recommendations should be regarded as interim guides pending the formulation of a new code. In conclusion, he would reiterate that, in so far as the absence of sanction allowed, it would seem reasonable that the new code should have but one aim in view, and that was the objective furtherance of rational nomenclature.

PROCEEDINGS OF THE GENERAL MEETING
27 April 1944

held jointly with The Zoological Society of London.

Mr. C. C. Hentschel, Vice-President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 23 March 1944, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last meeting :—Sir Buckston Browne, the Lady Isabel M. P. Browne, Mr. J. G. Crowther (British Council), Mr. E. L. Hillier, Mr. W. S. Lacey, the John Innes Horticultural Institution and the London Shellac Research Bureau.

Read for the first time certificates of recommendation of the following candidates for Fellowship : in favour of the Rev. Richard B. Abell, M.A., Geoffrey Clough Ainsworth, Ph.D., Albert Victor Bell, Ralph Dennell, D.Sc., Douglas Charles Harrod, Collingwood Ingram, Charles MacKechnie Jarvis, Dr. Richard Klein, Llewelwyn Cyril Lloyd, Cecil W. Miles, William Raymond Philipson, Nicholas Polunin, M.S., M.A., D.Phil., D.Sc., Francis Rose, the Lord Rothschild, Ph.D., Sydney Smith, M.A., Ph.D., Frederick Archibald Sowter, William Gladstone Templeman, M.Sc., Ph.D., George Trapp, M.A., Ph.D., Ethelwynn Trewavas, D.Sc., Norma Mary Waterman and Henry Newcome Wright, LL.D.

The Vice-President in the Chair reported the deaths of Mr. L.V.Lester-Garland, M.A., F.L.S., Mr. E. C. Stuart Baker, C.I.E., O.B.E., F.L.S., and Mr. C. E. Britton, A.L.S.

The following communication was read and discussed :—

Hooker Lecture.

Pachytheca and anomalous early plants. By Professor W. H. Lang, F.R.S. [To be printed in full in the Journal, Botany.]

The Vice-President in the Chair expressed the thanks of the Society to Professor Lang and invited comments. Professor F. E. Weiss, Professor T. M. Harris, Dr. H. Hamshaw Thomas and Mr. I. H. Burkill made some comments.

PROCEEDINGS OF THE GENERAL MEETING 11 May 1944

held jointly with The Zoological Society of London.

Mr. A. D. Cotton, O.B.E., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 27 April 1944, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last meeting :—Dr. R. E. C. Armattoe and Professor F. E. Weiss.

Read for the first time certificates of recommendation of the following candidates for Foreign Membership :—Dr. L. H. Bailey and Dr. V. Dogiel.

Read for the first time certificates of recommendation of the following candidates for Associateship :—Robert Stanley Trickett, Dr. Marie V. Lebour and Dr. V. Tchernavin.

The President reported the death of Mr. Hugh Neville Dixon, M.A., F.L.S.

The following communications were read and discussed :—

Mr. L. R. Hayward. Exhibit of the products of the Potato. (Discussed by Lt.-Col. W. P. C. Tenison, D.S.O., Dr. M. A. Brett, Dr. J. G. Hawkes, Dr. R. N. Salaman, Mr. I. H. Burkill, Dr. J. Ramsbottom, the President ; Mr. Hayward replied.)

Dr. Redcliffe N. Salaman, F.R.S. The early European Potato : its character and place of origin. (Discussed by Mr. I. H. Burkill, Dr. J. G. Hawkes, Mr. C. M. Driver, Dr. R. Melville, Dr. J. Ramsbottom, Mr. A. H. G. Alston, Mr. H. H. Crane and the President, who moved a vote of thanks to Dr. Salaman.) [To be printed in full in the Journal, Botany.]

Dr. Ralph Dennell. Luminous organs in Crustacea. (Discussed by Dr. J. P. Harding and Mr. D. J. Scourfield ; Dr. Dennell replied.)

The President announced that the title of his Presidential Address on 24 May would be ' The megaphytic habit in the African Tree Senecios and other genera '.

PROCEEDINGS OF THE ANNIVERSARY MEETING ON 24 May 1944

Mr. A. D. Cotton, O.B.E., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 11 May 1944, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last meeting :—Mr. B. Alwyn Jay, Professor Sydney Mangham, Mr. G. F. Sleggs and Dr. F. E. Zeuner.

Read for the second time, certificates of recommendation of the following candidates for Foreign Membership :—in favour of Dr. Liberty Hyde Bailey and Dr. V. Dogiel.

Candidates for membership were balloted for and elected :—

As Fellows :—Rev. Richard B. Abell, M.A., Geoffrey Clough Ainsworth, Ph.D., Albert Victor Bell, Ralph Dennell, D.Sc., Douglas Charles Harrod, Collingwood Ingram, Charles MacKechnie Jarvis, Dr. Richard Klein, Llewelwyn Cyril Lloyd, Cecil W. Miles, William Raymond Philipson, Nicholas Polunin, M.S., M.A., D.Phil., D.Sc., Francis Rose, the Lord Rothschild, Ph.D., Sydney Smith, M.A., Ph.D., Frederick Archibald Sowter, William Gladstone Templeman, M.Sc., Ph.D., George Trapp, M.A., Ph.D., Ethelwynn Trewavas, D.Sc., Norma Mary Waterman and Henry Newcome Wright, LL.D.

As Associates *honoris causa* :—Dr. Marie V. Lebour, Dr. Vladimir Tchernavin and Robert Stanley Trickett.

The Bye-Laws regulating the Election of Council and Officers having been read by the Assistant Secretary, the President declared the Ballot for new Members of Council to be open, and voting began. The President thereafter appointed the Rev. Canon F. W. Galpin, Miss M. Rathbone and Mr. E. W. Mason as Scrutineers of the Ballot.

The Ballot was closed at the due time, and the result declared to the Meeting. New Members of Council : Prof. A. J. E. Cave, Capt. Cyril Diver, Dr. Edward Hindle, F.R.S., Mr. A. A. Pearson and Lt.-Col. R. B. Seymour Sewell, C.I.E., F.R.S.

(The retiring Councillors were Dr. E. S. Russell, O.B.E., Mr. J. R. Norman, Mr. R. H. Burne, Dr. G. S. Carter and Prof. F. T. Brooks, F.R.S.)

The President declared the Ballot for Officers to be open and voting began. The Ballot was closed at the due time, and the result declared to the Meeting. Officers.—*President* : Mr. A. D. Cotton, O.B.E. ; *Treasurer* : Colonel F. C. Stern, O.B.E., M.C. ; *Deputy Treasurer* : Dr. B. Barnes ; *Botanical Secretary* : Dr. B. Barnes ; *Zoological Secretary* : Dr. Malcolm A. Smith.

The Deputy Treasurer presented the Accounts of the Society, duly audited, for the year 1943–4, and made the following Financial Report :—

The Treasurer's Report.—Printed copies of the Treasurer's Accounts for the Financial Year which ended on 30 April 1944 are before the meeting. The statement was prepared by the Professional Auditors, who certify as to detail : the Audit Committee has inspected the books, verified the investments and passed the Accounts and the action of the Committee has been confirmed by Council.

At first sight the balance for the year seems to stand at about £350 less than it did at the end of the last financial year : an explanation is

needed. Last year's balance included £68 3*s.* 11*d.* of Composition Fees awaiting investment and not available for general purposes; that money has now been invested. During the year the General Account has been diminished by the transfer of £600 to the Reserve Fund (which now stands at £1,450) and of £100 to the Library Account. So the apparent fall in the balance by no means indicates that the Society is by that much worse off.

It has been necessary to pay rather more to Fire Guards during the year, and the transport of some 3,000 of our books to places of possible safety cost about £8. But these items were more than offset by a welcome reduction in the rate of the War Damage Contribution, so that, on balance, we spent £55 less than we did last year in meeting expenditure directly due to the war.

The collection of the Annual Contributions remains a difficulty. A number of Fellows overseas, and, regrettably, a few in this country, are in arrears for one or more years; the arrears now total over £600. Efforts are being continued to collect what is owing. During the year £123 have come in, but it seems that arrears in contributions will continue to trouble the Treasurer at least until the end of the war. Fellows who do not pay their Annual Contributions by arrangement with their bankers can help the Society by adopting this convenient method of payment.

During the year thirteen Fellows have compounded their subscriptions. The permanent investments of the Society have thereby been increased by some £335, but there is a loss of annual income to the Society. Under present conditions there is greater need of annual income than of relatively small additions to permanent investments. Fellows who are thinking of compounding are asked to try to remain Annual Contributors, at least until the Society has been able to adjust itself to post-war conditions.

We may have come to the end of the changes in our investments caused by the compulsory sale of overseas holdings. The last £530 worth of Indian securities was sold during the year, and replaced by an equivalent amount of 3 per cent. Savings Bonds. Our overseas investments now consist of about £2,500 in Australian stocks, which, it is hoped, will remain undisturbed. The market value of our investments is somewhat lower than at this time last year, but the income is not affected, and the fall in value is not serious.

Your Council keeps a vigilant eye on expenditure, and Fellows may rest assured that nothing is spent without due thought. The financial position of the Society appears to be satisfactory, but this does not mean that we are prosperous. The President will acknowledge some generous donations, and had we not received these, and had not our output of publications been affected by the war, we should have finished the year with much less money in hand. It is almost certain that, at this time next year, the Treasurer will report a greater expenditure on printing and a substantially smaller balance.

Our Society greatly needs a good addition of suitably qualified new Fellows to help in our work in every way, especially by enabling the Treasurer to find the money which Council will need to re-establish our affairs when conditions become more settled.

Treasurer's Accounts for the

(Presented at the Anniversary

Receipts and Payments of the Linnean Society

General

Receipts	£ s. d.	£ s. d.
To Balance at 1 May 1943 :—		
Current Account at Bank	202 0 11	
Deposit Account Post Office Savings Bank.....	1157 7 3	
Cash in hand	4 18 9	
		1364 6 11
„ Admission Fees		20 0 0
„ Arrears of Annual Contributions	123 3 8	
„ Annual Contributions for year	1865 14 4	
Do. in advance	56 1 8	
		2044 19 8
„ Do. of Associates		4 0 0
„ Composition Fees		335 12 10
„ Interest on Investments (including Income Tax recovered)		289 18 7
Do. Post Office Savings Bank Account		87 5 2
„ Sales of Publications :—		
Transactions	2 11 1	
Journals	43 0 8	
Proceedings	19 15 9	
		65 7 6
„ Donations in aid of Publications		200 0 0
„ Donations for General Purposes		1 0 0
„ Miscellaneous Receipts		34 7 6
		£4446 18 2

Library

Receipts	£ s. d.
To Balance 1 May 1943.....	72 9 4
„ Interest on Investments (including Income Tax recovered)	49 0 0
„ Donation	12 9
„ Deposit Account Interest	8 11
„ East India Railway Company Capital Repayment ..	530 0 0
„ Transfer from General Account.....	100 0 0
„ Donation deposit for Binding	100 0 0
	£852 11 0

Fellows' Postal

Receipts	£ s. d.
To Balance at 1 May 1943	52 8 1
„ Deposits during year	6 0
	£52 14 1

YEAR ENDED 30 APRIL 1944

Meeting, 24 May 1944)

from 1 *May* 1943 *to* 30 *April* 1944

Account

PAYMENTS	£	s.	d.	£	s.	d.
By Coal, Electric Current, and Gas				63	1	7
„ Repairs : Sundry				17	11	8
„ Taxes and Insurance				55	4	11
„ Miscellaneous Printing and Stationery				117	3	5
„ Petty Expenses and Postages				110	8	1
„ Fire Watching Expenses and A.R.P.				75	3	5
„ Publications :—						
Printing	420	1	2			
Illustrations	29	9	0			
Distribution	24	2	9			
				473	12	11
„ Salaries, Wages, etc. (including £12 8*s.* 3*d.* Travelling Allowances)				1155	11	8
„ 'Zoological Record' Donation				15	0	0
„ International Commission on Zoological Nomenclature, Donation				10	0	0
„ War Damage Insurance (Library, Furniture and Fittings)				132	10	0
„ Staff Annuities (Annual Premiums)				100	0	0
„ Purchase of £278 16*s.* 0*d.* 2½ per cent. Consolidated Stock (Composition Fees)				226	17	6
„ Purchase of £176 19*s.* 3*d.* 3 per cent. Savings Bonds, 1960–70 (Composition Fees)				176	19	3
„ Transfer to Reserve Fund for Library and Renewals.				600	0	0
„ Transfer to Library Account				100	0	0
„ Balance at 30 April 1944 :—						
Current Account at Bank	168	6	5			
Deposit Account Post Office Savings Bank	844	12	5			
Cash in hand	4	14	11			
				1017	13	9
				£4446	18	2

Account

PAYMENTS	£	s.	d.	£	s.	d.
By Periodicals				59	13	8
„ Books				15	7	3
„ Purchase of £530 0*s.* 0*d.* 3 per cent. Savings Bonds, 1960–70				530	0	0
„ Balance at 30 April 1944 : Current Account	77	10	1			
Deposit Account	70	0	0			
„ Deposit Account Post Office Savings Bank	100	0	0			
				247	10	1
				£852	11	0

Account

PAYMENTS	£	s.	d.
By Withdrawal during the year	1	19	0
„ Balance at 30 April 1944	50	15	1
	£52	14	1

Separate Account

Receipts

	£	s.	d.	£	s.	d.
To Balance at 1 May 1943 :—						
Westwood Fund	44	7	10			
Trail Award Fund	29	9	2			
Crisp Award Fund	32	1	4			
Hooker Lecture Fund	143	0	0			
Goodenough Fund	6	12	8			
Minchin Fellowship Fund	10	10	5			
Carnegie Corporation Grant	752	17	1			
Reserve Fund	850	0	0			
				1868	18	6
,, Interest on Investments (including Income Tax recovered) :—						
Westwood Fund	9	17	10			
Trail Award Fund	3	10	0			
Crisp Award Fund	10	4	8			
Hooker Lecture Fund	21	8	8			
Goodenough Fund	7	14	0			
Minchin Fellowship Fund	3	0	0			
Staff Pension Fund	3	9	9			
				59	4	11
,, Transfer from General Account to Reserve Fund (Library and Renewals)				600	0	0
				£2528	3	5

Payments

	£	s.	d.	£	s.	d.
By Hooker Fund :—						
Lecturers' Fees and Expenses				31	10	0
,, Westwood Fund :—						
Cost of Illustrations				6	5	10
,, Goodenough Fund :—						
Transferred to Annual Contributions				8	10	0
,, Staff Pension Fund :—						
Purchase of £3 9s. 4d. 3 per cent. Savings Bonds 1955/65				3	9	9
,, Balance at 30 April 1944 :—						
Westwood Fund	47	19	10			
Trail Award Fund	32	19	2			
Crisp Award Fund	42	6	0			
Hooker Lecture Fund	132	18	8			
Goodenough Fund	5	16	8			
Minchin Fellowship Fund	13	10	5			
Carnegie Corporation Grant	752	17	1			
Reserve Fund	1450	0	0			
				2478	7	10
				£2528	3	5

Investments on 30 April 1944

General Account

£	s.	d.			Market Value 30 April 1944 £	s.	d.
1000	0	0	3½ per cent. London County Consolidated Stock 1958–68	@106½	1065	0	0
1000	0	0	Great Western Railway 4 per cent. Debenture Stock	@114½	1145	0	0
312	0	0	London Midland & Scottish Railway 4 per cent. Preference Stock	@ 77	240	4	10
338	6	8	3½ per cent. War Stock	@103	348	9	8
1000	0	0	3 per cent. Defence Bonds	@100	1000	0	0
2199	18	6	4 per cent. Australian Stock 1961–64	@109	2397	18	4
200	0	0	3 per cent. War Stock 1955–59	@101	202	0	0
1139	13	0	3 per cent. Savings Bonds 1955–65	@100½	1145	7	0
1547	18	4	2½ per cent. Consolidated Stock	@ 79	1222	17	1
176	19	3	3 per cent. Savings Bonds 1960–70	@100¼	177	8	1
					£8944	5	0

Library Account

£	s.	d.			£	s.	d.
450	0	0	Forth Bridge Railway 4 per cent. Stock (Bentham Bequest)	@103½	465	15	0
103	12	5	Surrey County 3 per cent. Stock 1961–66 (Wakehurst Bequest)	@100	103	12	5
191	12	7	4 per cent. Australian Stock 1961–64 (Walker & Morey Bequests)	@109	208	17	6
107	2	1	2½ per cent. Consolidated Stock (Stebbing Bequest)	@ 79	84	12	3
530	0	0	3 per cent. Savings Bonds 1960–70 (Tagart Bequest)	@100¼	531	6	6
					£1394	3	8

Separate Account

	£	s.	d.			£	s.	d.
£1063 10 7	232	5	0	Metropolitan Water Board 3 per cent. " B " Stock (Westwood Bequest)	@ 97½	226	8	10
	667	14	2	Ditto ditto (Hooker Lecture Fund)	@ 97½	651	0	4
	163	11	5	Ditto ditto (Goodenough Fund)	@ 97½	159	9	7
	100	0	0	New South Wales 3½ per cent. Stock, 1930–50 (Trail Award Fund)	@101	101	0	0
	409	11	1	2½ per cent. Consolidated Stock (Crisp Award Fund)	@ 79	323	11	11
£380 10 6	156	7	2	,, ,, ,, (Westwood Fund)	@ 79	123	10	5
	74	14	6	,, ,, ,, (Hooker Lecture Fund)	@ 79	59	0	8
	149	8	10	,, ,, ,, (Goodenough Fund)	@ 79	118	1	2
	234	19	9	3 per cent. Savings Bonds 1955–65 (Staff Pension Fund)	@100½	236	3	3
	100	0	0	,, ,, ,, 1960–70 (Minchin Fund)	@100¼	100	5	0
						£2098	11	2

B. BARNES, *Deputy Treasurer.*

We have (in conjunction with the Professional Auditors, who certify as to all details) audited the Accounts of the Society for the year ended 30 April 1944, and found them correct. We have verified the Investments and Bank Balances.

Dated this 12 May 1944.

W. B. KEEN & Co., *Chartered Accountants,*
224 Regent Street, London, W.1.

A. D. COTTON,
J. E. DANDY,
N. A. MACKINTOSH,
I. HENRY BURKILL,
E. M. WAKEFIELD,
D. J. SCOURFIELD,
} *Audit Committee.*

On a motion by Dr. Margaret A. Brett, seconded by Mr. W. S. Rowntree, the Report and Statement of Accounts were adopted.

The Librarian and Assistant Secretary presented his Report.

Librarian and Assistant Secretary's Report.

List of the Society.—Since the last Anniversary Meeting the Society has lost 24 members. The detailed statement is as follows :—

16 *Fellows by death.*—Percy Appleyard, E. C. Stuart Baker, C.I.E., O.B.E., Edward Thomas Brown, J.P., Sir John Bretland Farmer, F.R.S., Alan Campbell Gardiner, Walter Ambrose Heath Harding, Lester Vallis Lester-Garland, Cecil Victor Boley Marquand, Sir Edward Bagnall Poulton, F.R.S., Lt.-Col. Sir David Prain, C.M.G., C.I.E., R.N.O., F.R.S., Dr. Tom Stansfield, Dr. Fred Stoker, Colin F. Symington, John Scott Thomson, Rev. Robert Usher, William Percival Westell.

3 *Foreign Members by death.*—Carl Christensen, Axel Einar Lönnberg, William Albert Setchell.

2 *Associates by death.*—Charles Edward Britton, Frederick Chapman.

3 *Fellows by withdrawal.*—Anna Birchall Hastings, Tom Clifford Denston, George Kenneth Sutherland.

During the Session 1 Fellow and 3 ordinary Associates have been elected ; all have qualified. The present number on the List of Fellows is 614.

Library.—Between 1 May 1943 and 30 April 1944 seven books have been purchased and 35 books, 212 parts of periodical publications and 136 reprints have been presented. The number of volumes borrowed by Fellows and Associates was 751 and by the National Central Library 234. 272 signatures were recorded in the Library Visitors' book.

During the same period about 3,000 volumes, mainly selected sets of periodical publications and volumes of opuscula, have been removed from the Library to places of greater safety.

Linnaean Collections.—During the past year my compilation of the Catalogue of the Linnaean Herbarium has been completed, and a portion of the manuscript is now in the printers' hands.

The President's Review.

The President addressed the Meeting on the welfare of the Society as follows :—

In order that Fellows may be more closely associated with the affairs of the Society it has become the practice at the Anniversary Meetings to devote more time than formerly to details of its activities. But before referring to these, I must express my profound appreciation of the great honour you have done me in electing me your President. I should like also to take this opportunity of thanking the Officers of the Society, the Members of Council and the staff for their help and support, especially valuable to a President during his first year of office.

The Assistant Secretary has given you statistics as to the Society's position. You will have observed that there are 614 Fellows on the list, and will have noted the Deputy Treasurer's remarks that the 'Society greatly needs a good addition of suitably qualified new Fellows'. The 614 are not all active Fellows. Several are serving in H.M. Forces and a few, we regret to know, are Prisoners of War. These include: R. J. Chittenden (F.M.S.); P. D. Critopoulos (Greece); G. A. C. Herklots (Hong Kong); R. E. Holttum (Straits Settlements); J. N. Milsum (F.M.S.); Mrs. H. H. Simmons (France).

You have been asked today to approve the selection of three Associates *honoris causa*, Dr. Marie V. Lebour, Dr. Vladimir Tchernavin and Mr. Robert Stanley Trickett, and by their election to bring the number up to its full strength. You will also have heard the names of two scientists, Dr. L. H. Bailey and Dr. V. Dogiel, proposed for Foreign Membership. If elected (at the next Meeting) the list will stand at 49, thus leaving one vacancy. Four of our younger scientists have taken advantage of the new class of Associates (by payment of a subscription) and have been elected and qualified.

The Marine Algae Committee of the Society has held two Meetings during the season, the principal subjects discussed being Algal ecology in New Zealand, Algal ecological terminology, and ecological 'passports' as applied to Marine Algae.

As in previous years, the Society has been glad to place its Meeting-room at the disposal of other Societies for their meetings. In many cases no charge is made, the Council feeling that in this way the Society is helping to further the study of natural history. Twelve Societies have used our rooms during the Session, namely, the British Mycological Society, the Aquinas Society, the S.E. Union of Scientific Societies, the British Ecological Society, the Society for the Promotion of Nature Reserves, the Botanical Research Fund, the Genetical Society, the Botanical Society and Exchange Club, the British Association Committees, the Malacological Society, the Society for Experimental Biology, and the Association of Applied Biologists.

Amongst the sixteen Fellows whom we have lost during the year there are two very distinguished names. Both these Fellows were warm supporters of the Society and both had been past-Presidents. I refer to Sir Edward Poulton and Sir David Prain.

There is one change in the Society's Officers which I must dwell upon, namely, the retirement of the Botanical Secretary, Mr. I. H. Burkill. Mr. Burkill has served in this capacity for seven years, but has lately found the pressure of work too much for him. During that time he has given Fellows wholehearted service. He helped to carry the Society through the difficult days of 1940 and '41, and it is in large measure due to his energy and enthusiasm that we have again been able to hold so many and such successful Meetings. His knowledge of Indian and Malayan botany has, moreover, been particularly helpful. The Society could have had no more loyal and hardworking Botanical Secretary, and I, personally, shall always feel indebted to him for his never-failing help and advice.

We lose also the services of the caretaker of our rooms, Mr. G. Brown, who has retired after twenty years' faithful service. Fellows will remember his devotion to duty during the air raids, which was referred to by Dr. Russell in his Presidential Address in 1941.

The Deputy Treasurer has given you an account of his stewardship, and it is gratifying to learn from him that our financial position is not unsatisfactory. The Treasurer, Col. Stern, is, as you know, a Commanding Officer in the Home Guard, and he asked to be temporarily relieved of his duties. Dr. Barnes very kindly agreed to act as Deputy Treasurer, and we are greatly indebted to him for carrying on so ably in the Treasurer's absence.

The Deputy Treasurer has prudently placed in a reserve fund a sum which we cannot now spend economically but which we must spend when the war is over. The Council has laid it down that the first call on this reserve fund shall be for Library fittings.

I may refer here to some welcome donations received or promised during the year. These include :—

£100 from the Rockefeller Fund (distributed by the Royal Society).
£100, a Parliamentary Grant in Aid (distributed by the Royal Society).
£100 from our Fellow, Mr. J. Insch of Boscombe, to be used for the repair and binding of his library of books on Tea, which he intends to bequeath to the Society.
A promise of £50 from Gonville and Caius College, Cambridge, to assist in the printing of Dr. V. J. Chapman's paper on the Vegetation of Jamaica.

The Council has, moreover, been informed that, subject to certain life interests, the Society may expect to benefit from the estate of our late Fellow Mr. Percy Appleyard, Albany, Western Australia. It is peculiarly gratifying to receive a bequest from a Fellow who has resided in Australia ever since he was elected, forty years ago.

You are aware that under the will of the late Treasurer, Mr. Francis Druce, we were permitted to take from his library any books which were needed for our rooms in Burlington House. You will also remember that Mr. Druce's library was destroyed by fire at the time he lost his life. We have been in consultation with his solicitors and have agreed to accept the sum of £50 as insurance money. This sum will be spent on books at an appropriate time.

My predecessor in this Chair, when addressing you two years ago, informed you that the Council was greatly concerned at the congested state of the library and the need for re-arrangement. A small sub-committee was then set up with a view to carrying out preliminary work for future re-arrangements. This sub-committee has been active and has prepared a complete set of title-slips which are now being classified on a subject basis. The warm thanks of the Society are due to Dr. Margaret Brett, Miss M. Rathbone and Mr. J. Ardagh, who, together with the Secretaries, have prepared the slips.

The Library Committee itself has a heavy and difficult task before it, and Mr. C. C. Hentschel, a Member of Council, was asked if he would act as Chairman. Two meetings have been held and the methods by which the extension and re-arrangement of the Library could be carried out have received careful and detailed consideration. A small sub-committee was appointed to examine the two principal problems—the best method of providing extra shelving in a number of small rooms at our disposal, and the question of the re-arrangement of the books under subject headings. The Library Committee has considered this report and has forwarded it to Council for consideration. It is hoped that it will be possible to commence reorganization on the lines suggested as soon as the general conditions in the country permit of the necessary structural alterations being carried out.

As you have heard, with the recrudescence of air raids in London earlier in the year your Council removed from the Society's rooms about 3,000 volumes and conveyed them to two institutions outside London. You will observe that the Book of the Charter and Bye-Laws is not in its usual place on the table—it is one of the books which were sent away, and is now in the charge of two responsible Fellows of the Society living in the country. Any new Fellow now admitted signs on a single sheet of paper which will be incorporated later in the Roll and Charter Book.

Some Fellows may not have realized that the Society has held within the Session as many Meetings as in times of peace, though these extend over a longer period of the year. The Zoological Society of London has been associated with us, and by bringing communications before us has helped materially in making the Meetings successful. We are indebted to our Zoological Secretary for enabling us to profit by this intercourse with the Zoological Society.

A Meeting at the end of last Session was devoted to the celebration of the Centenary of the Rothamsted Experimental Station, when Sir John Russell, the retiring Director, and three of his staff addressed the Society. At the actual Centenary Celebrations, held at Rothamsted in July, the Society was represented by Prof. F. T. Brooks. A Meeting in November was devoted to commemorating the Centenary of Robert Fortune's first departure for China, and in staging the exhibits for this Meeting we were assisted by the Royal Horticultural Society.

In 1935, when the 'Proceedings' were cast into their present form, the President, Dr. Calman, announced that four Parts would be issued yearly so spaced as to insure prompt publication. War-conditions made it necessary to reduce the number of Parts to three, and owing to difficulties with regard to printing there has been delay in publication. The time-lag, however, is not increasing, but has slightly diminished. The printed matter for the Session 1940–1 consisted of 316 pages, for the Session 1941–2, 315 pages, and for the Session 1942–3, 316 pages. Such equality was not aimed at, but indicates how the Society has pursued the even tenor of its way, a remarkable achievement when it is considered that we are in the fifth year of a world war.

During the year one Number of the Journal (Botany) and one Number of the Journal (Zoology) have also been published. Both are small in size compared with normal Numbers.

An innovation with regard to the Society's publications has been the issue (as separate publications) of Synopses on various groups of the British Fauna. Every biologist engaged in field-work knows how essential it is to have available an up-to-date systematic treatise on the groups concerned. Zoologists are less well served in this respect than botanists, and for some years past the Society has had the provision of a series of systematic monographs under consideration. We are much indebted to our Fellow, Mr. D. M. Reid, for stimulating interest in this project, and largely as a result of his activities two Numbers are already on sale and a third is ready for press. It is planned to publish in this series synopses of all groups in need of revision, as material and specialists become available for the necessary research to be undertaken. The Council has appointed Mr. Reid as Editor. Having been a working systematist for many years of my life I view this aspect of the Society's activities with particular sympathy. A breakaway such as this from long-established custom, with the express purpose of providing help to the field-worker, may, I think, be taken as the sign of a healthy outlook in the Society.

The PRESIDENT then delivered his Address, ' The megaphytic habit in the African Tree Senecios and other genera '.

On its conclusion, Dr. HUGH SCOTT, F.R.S., moved ' That the President be thanked for his excellent Address, and that he be requested to allow it to be printed and circulated amongst the Fellows '. The motion was seconded by Mr. A. H. G. ALSTON and, being put to the meeting, was carried with acclamation.

PRESIDENTIAL ADDRESS.

By A. D. COTTON, O.B.E.

THE MEGAPHYTIC HABIT IN THE TREE SENECIOS AND OTHER GENERA.

I HAVE chosen as the subject for my Address to-day the peculiar habit exhibited by the so-called Tree Senecios of the African mountains. Eleven years ago I had the honour of bringing before the Society a general account of these remarkable plants and touched upon their taxonomy, morphology, distribution and ecology. Since then several papers on the group have been published, but no comprehensive monographic treatment has yet appeared. I thought, therefore, it might be of interest to deal with one aspect of the many problems they present, and have selected a chapter from a detailed paper which, I hope, will later be published by the Society. In preparing this for my Address the chapter has, however, been largely re-written.

The term ' megaphyte ' was first proposed in a paper read by me at the International Botanical Congress at Amsterdam in 1935 for certain perennial plants of non-arboreal genera (i.e. not true trees) which develop

a 'largeness' of habit (often in contrast to other members of the genus) and exhibited in the vegetative portion of the plant by unusual bulk or by exceptional height *. The plants in question are characterized by the possession of one, or at the most only a limited number of, active growing points, and are, therefore, unbranched or only very slightly branched, and their peculiar habit is definitely related to the few outlets available for expansion. It is clear that this basis of grouping is taxonomically artificial and also that the group is not a sharply defined one.

Megaphytism in plants may be looked upon in the light of the familiar fact that the more a given body is divided the smaller the size of the component parts. If the plant body, or the main axis, instead of being richly branched, remains undivided, or is but slightly divided, a growth-form results which is sufficiently unusual to claim attention and even to merit a special term. These reflections arose as a result of the consideration of the tall, single-stemmed Lobelias, with their huge terminal inflorescence, and of the massive architecture of the unbranched or slightly branched Tree Senecios of the African mountains. The term 'giant' has often been used in this connection (e.g. Giant Cacti, Giant Senecios), but as the word gigantism has another connotation in botany (in connection with polyploidy), the term megaphyte has been devised to designate the plants now under consideration.

As thus defined, megaphytism shows itself in three chief forms: (1) in Monocotyledons, such as *Aloë*, *Agave* and many Palms, where it usually expresses itself in the form of a *few* large rosettes of leaves which are borne on either short or tall stems; (2) in the Cactaceae and other Dicotyledonous families, where stem-succulence is the characteristic feature; and (3) in certain Dicotyledons where the main aerial stem continues to grow and increase in size for many years and retains to a certain extent its herbaceous character, developing a smaller amount of wood than is normally found in a tree. The enlarged vegetative portion is at length succeeded by a huge inflorescence, though the individual flowers show little increase in size over the herbaceous species. It is to this group that the Giant Echiums, the Tree Lobelias, the Tree Senecios and the Espeletias of the Andes belong, and it is of these which I wish specially to speak. In two quite unrelated groups, namely, in the Cycadaceae and the Tree Ferns, we find the same type of giant habit. It may be repeated here, that the one character which links together all these plants, so diverse in their natural affinity, is the long-continued growth of the main axis, with a complete or almost complete suppression of lateral bud-development. Before dealing with our chief concern, the remarkable Dicotyledonous megaphytes, a few words may be said about the two other types.

The Monocotyledons, on account of their very different stem-anatomy, must be considered apart from the Dicotyledons. Several remarkable megaphytes are to be found in the Liliaceae and Amaryllidaceae, where

* The paper was read but an abstract only was published. (Congress Proceedings, XI, p. 305.) The term megaphyte should not be confused with Raunkiaer's life-form term megaphanerophyte.

the peculiar habit is usually found in plants growing in arid conditions, and also in the Bromeliaceae, which are typically moisture-loving. Many of the genera concerned, such as *Agave*, are monoblastic (one-shooted), though others, such as *Yucca* and certain Aloes, are oligoblastic (few-shooted). They are usually long-lived, and growth may, therefore, be concentrated for very many years in a single shoot with its rosette of large leaves. Although the stems may be quite short, as in *Agave* and on some Aloes, the actual size of the plant may, owing to the presence of huge succulent leaves, be very considerable. A more striking example of a megaphyte than the massive *Agave americana* so often seen in Botanic Gardens could, indeed, hardly be imagined. In others, the stems may be more or less elongated and branched as in *Yucca*, *Aloë*, *Dracaena* and *Cordyline*, where a megaphytic growth of less striking form is found.

The Palms include a remarkable series of monoblastic megaphytes, ranging from dwarf species, such as *Chamaerops humilis*, small specimens of which, with their marcescent foliage, are strikingly reminiscent of a young unbranched Tree Senecio, to species such as the Date Palm and the Coconut Palm, where the stem elongates to a great height and in which the phenomenon under consideration is exhibited in spectacular form.

Megaphytism in different forms is found in other Monocotyledons, but these cannot be discussed here. Two genera, however, may be mentioned, since they afford an interesting comparison with the Tree Senecios, namely, (1) the South American *Puya Raimondii* and other species occurring at very high altitudes on the Andes under conditions comparable to those of the equatorial mountains of Africa, the stout upright stems of which are clothed with a rosette of leaves and surmounted by an immense inflorescence; and (2), the slightly branched 'Grass Trees' or 'Black Boys' of Australia, *Xanthorrhoea* spp. (Juncaceae), with their bulky stems clothed with a mass of marcescent foliage, resulting in a growth-form much resembling that of certain African Tree Senecios.

A very few words must suffice for the stem-succulent form of megaphytism. This type of habit, of which the Cacti provide an extensive and remarkable series, is usually a response to an arid environment; the leaves of the plant are either reduced, replaced by spines or entirely suppressed. In the monoblastic Cacti megaphytism is seen in the spherical, conical and cylindrical forms of growth, varying in size from small examples to the huge columnar type seen in *Carnegiea*. In the branched series megaphytism is strikingly exhibited in the candelabra type, and also to a lesser degree in the *Opuntia* type. The Giant Cacti of California, Arizona and Mexico are perhaps some of the most remarkable megaphytes in existence.

The growth of many of the American Cacti is paralleled in the genus *Euphorbia* in the African tropics. In this genus there are fewer monoblastic species. But there are many which are oligoblastic and which give rise to the candelabra type of growth, where megaphytism is still seen on an impressive scale. In *Euphorbia* there is every transition from monoblastic species to polyblastic species; in this genus it is clear that with an increasing number of shoots megaphytism becomes less

striking, and when polyblastic species, such as *E. antiquorum*, are considered, no trace of ' bigness ' is presented. Few-shooted and many-shooted species of *Euphorbia* may be seen growing side by side in the African tropics, the one being megaphytic and the other not so.

In most other families of the Dicotyledons where stem-succulence occurs it is associated with lack of branching, which results in a certain ' coarseness ' of habit, as in *Asclepias* spp., *Pelargonium* spp., and many other genera. All these plants provide interesting examples of growth-form and lead up to what we have termed megaphytism. The so-called Giant Sedums of the Canary Islands, especially species of the genus *Aeonium*, show an interesting variation. Here megaphytism on a small scale is displayed, and it is associated with leaf-succulence. The species are often monoblastic and the stem reaches an unusual height for the family—i.e. up to 6 or 8 ft. This type of growth, it may be noted, finds its exact parallel in the American genus *Echeveria*.

It appears advisable in any review of megaphytism to include a reference to these succulent plants, but it is fully realized that the form in which that phenomenon shows itself in them is not comparable to that found in other Dicotyledons, since their anatomical structure is different and their physiology is exceptional and of a highly specialized nature.

We now pass to my main subject, namely, the remarkable examples of the megaphytic habit exhibited in other Dicotyledons. It will be found that these plants belong to genera which have herbaceous rather than arboreal affinities, and as will be shown later, their stem structure is characterized by features which are regarded as typical of herbs. Though this form of megaphytism is shown to a varying extent in other genera, there are four in which it occurs to a very striking degree, namely, the Echiums of the Canary Islands (Boraginaceae), the Tree Lobelias of Hawaii and Africa (Campanulaceae), the Espeletias of the High Andes, and the Senecios of the African mountains, both of which are members of the Compositae.

It will be observed that the habit is found in diverse families. It is similar in each genus—a single or slightly branched stem bearing a number of large leaves in an apical rosette. Except in *Espeletia* this is followed by the production of an immense inflorescence which in extreme cases is out of all proportion to that found in most other members of the genus. The individual flowers, however, are usually of normal size. Though a considerable amount of xylem is developed and the plants may assume the dimensions of a small tree, they retain to a certain extent their herbaceous structure, and except in the Senecios the amount of wood developed is not great. It is to be noted that these striking examples of megaphytism are found either in the warm temperate zone or on mountains in the tropics.

We may now touch on the salient features exhibited respectively by these four genera. The special interest of the Echiums of the Canary Islands lies, firstly, in the fact that they afford a typical example of megaphytism in a genus which is admittedly entirely herbaceous ; secondly, that though the genus is widely distributed, the phenomenon is only found in

the species on these islands ; and thirdly, that they provide an example of megaphytism in the temperate zone. The intense insolation which is experienced in these islands no doubt plays a part in the development of the peculiar habit (as will be explained later). In the Canary Islands there are transitions from the much-branched perennial species of moderate stature and moderate-sized inflorescence to the stately, short-lived, unbranched species with a greatly elongated thyrse *. A field study of this aspect of their morphology would be of interest. The stem is bulky, up to 5 ft. high, with a large pith, and the large imposing inflorescence may reach a height of 7 ft. The growth-form of the monoblastic species forms a close parallel to that found in the Tree Lobelias.

The giant Lobelias which occur in various parts of the tropics are found on the African mountains in company with the Tree Senecios. A recent revision by Miss E. A. Bruce shows there are about twenty species in East Africa. They extend from the high mountains of Abyssinia to those of southern Tanganyika, and are, therefore, not so exclusively equatorial as the Senecios, and since they are found at low levels and reach almost to the upper limit of vegetation their altitudinal range is also considerably greater. In form they consists of an herbaceous or semi-herbaceous stem which varies from a foot to ten or more feet in height, and which bears an apical rosette of large leaves and eventually a large, often spectacular, terminal inflorescence. Most of the African species are monoblastic, but a few are slightly branched. Even in the dwarf species the stout herbaceous stem, with its terminal rosette of leaves and sturdy erect inflorescence, is very striking. Other species, such as the widespread *L. Gibberoa*, which is grown in greenhouses in this country and can thrive in the open in the Scilly Islands, may have a stem 7 feet high, with a huge inflorescence of equal length. All the African species are monocarpic. The tall, slender stem of *L. Gibberoa* has been examined at Kew. It shows a cortex devoid of cork (at any rate near the apex), a narrow vascular cylinder, a layer of pith and a large central cavity, thus presenting the features of an herbaceous type of stem.

An even more impressive series of Lobelias and allied genera is found in the Hawaiian Islands (lat. 20° N.). These have recently been monographed by Rock. They are found from sea-level to 7,000 feet, and range from sub-herbaceous forms 3–4 feet high to tree-like plants 40 feet high. Some possess a single axis, others are oligoblastic, and yet others much branched. Some of these plants are strikingly megaphytic. Rock does not allude to their anatomical structure, but it would appear that the monoblastic forms are the more herbaceous.

The Espeletias are of interest in possessing a similar general growth-form and appearance to the Tree Senecios, but on a much smaller scale. They occur in the tropics and at altitudes and latitudes on the Andes comparable to those of the high mountains of equatorial Africa. In

* I am greatly indebted to our Fellow, Major A. A. Dorrien-Smith, for the opportunity of examining a series of fresh specimens of Echiums from his garden at Tresco.

contrast to the Senecios, the leaves composing the dense rosette are long and narrow, but when dead they hang down as a huge mass of marcescent foliage, so that the external resemblance to *Senecio* is heightened. They are much less branched, this being due doubtless to their monopodial growth, with several lateral inflorescences instead of a single terminal one. The majority of the species are dwarf, a few produce a thick unbranched stem, and only in four species, out of about thirty which have been described, does the stem become tall and branched. Their taxonomy and phylogeny have recently been discussed in an interesting paper by Smith and Coch.

The fruits of *Espeletia* are without a pappus, and for this and other reasons the problem of their origin and distribution is different from that of the Senecios. But within the thirty known species there appears to be a complete series from dwarf to tall branched forms. The authors mentioned state that the branched species have ' a caudex composed of true wood ' and that the simple erect species have stems which, though perennial, are ' softer in texture '. Investigations at Kew show that Espeletias possess a wide pith, a well-developed cortex, and a narrow vascular cylinder which is composed of quite distinct bundles separated by medullary rays—a structure typical of many herbs belonging to the Compositae. It would appear, therefore, that *Espeletia* is a typically herbaceous genus which has responded to the ecological conditions of the paramos of the Andes in a similar way to the Senecios, though on a less impressive scale.

The Tree Senecios are dealt with in detail in the full paper. The development of a typical specimen is as follows :—The main stem grows for a number of years, remains unbranched, and, when clothed with dead foliage, often assumes the appearance of a massive trunk. After the large inflorescence is at length produced, two lateral buds develop and a branched stem is the result. After a further period of years, flowering again takes place (often on both shoots simultaneously) and a pair of lateral buds grow out from below each inflorescence. This process is repeated and gradully the plant assumes a candelabra-like form. There are, however, many irregularities, due either to damage or to only one or occasionally three lateral buds developing. In height the plants range from 6 to 15 ft. or even to 20 ft. The number of times a plant flowers varies with the species and with the altitude. At extreme altitudes many examples flower only once, and probably under the most favourable conditions sympodial branching as the result of flowering seldom takes place more than three or four times.

Whether unbranched or branched, such plants afford the most striking and magnificent example of this type of megaphytism, and botanists have not hesitated to call them trees. Their woody trunks, especially if branched and clothed with marcescent foliage, justify in a general way the use of this term. On Kilimanjaro, and on other isolated peaks, they usually occur singly, or in small groups, but on the huge massif of Ruwenzori, and to a lesser extent on Mt. Elgon, they cover large areas which have been termed ' groves ' or even ' forests ', and form the dominant feature of the vegetation.

In habit the species are strikingly different from all other Senecios (a genus embracing a great variety of growth-forms), and some botanists have suggested that they should be accorded separate generic status. Hauman regarded them as forming a subgenus, for which he proposed the name *Dendrosenecio*, the large leaves and inflorescence and the woody nature of the stem being the chief diagnostic characters. Hutchinson and other taxonomists believe that in view of the identity of their floral structure with herbaceous species they should be retained within the genus *Senecio*, though they do not object to their being grouped together in a subgenus.

Included within *Dendrosenecio* are two dwarf species or 'cabbage' forms which are of exceptional interest. It is unfortunate that less is known of these than of typical species and that their stem-anatomy has never been studied. They exhibit the phenomenon of megaphytism, however, in the rosette of large leaves and in the huge inflorescence. They are believed to live for five to seven years. No lateral buds develop, and, like the Lobelias, they die after flowering.

We may now attempt to account for the origin of the peculiar habit of these high mountain species. In my study of the Dendrosenecios attention was at first concentrated on ecological factors, and in the paper read at the Amsterdam Congress this aspect of the investigation was given prominence. But the enquiry lacked precision, since the plants stood apart from all other members of the genus, and there appeared to be no other species on the mountains to which they were even remotely related. It had, indeed, been suggested that they might represent an arboreal genus which had become almost extinct. Soon after the 1935 Congress Hauman's paper on the Tree Senecios of the Belgian Congo appeared. He dealt rather briefly with their anatomy. It was not until six years later, when Leighton Hare's paper on the Senecios of Kilimanjaro was published, that the significance of stem anatomy in throwing light on their possible origin was fully appreciated. Hare's paper, entitled 'A Study in Ecological Anatomy', was mainly concerned in showing how the anatomy of the three species of *Senecio* of that mountain, which occur in three separate altitudinal zones, is related to the increasingly severe conditions which prevail in their respective habitats. But he also showed that the stem in the young state possessed very numerous separate bundles (characteristic of many, but not all, herbs), that the cortical tissues were exceptionally developed, that the amount of xylem produced was relatively small, and that even in old age the Senecios retained a large pith, all of which are features characteristic of herbs rather than of trees. It was clear from this, that a study of the anatomy of other species of *Senecio*, and of that of other genera where megaphytism occurred in less striking form, might be useful in interpreting the origin of the remarkable habit of the mountain species.

In the absence of suitable African material fresh specimens of British Senecios have been drawn upon and have yielded interesting results. The stem structure of *S. vulgaris*, *S. squalidus* and *S. Jacobaea* resembles in miniature that of a young Tree Senecio. The bundles are separated from one another by medullary rays, and though this ray tissue becomes

lignified in old stems, especially in *S. Jacobaea*, the mature xylem is still characterized by broad rays. A larger and more woody species, *S. grandifolius* from Mexico, which is grown at Kew, shows a further stage in stem development, namely, the production of a stem with a wide cortex and a large pith, but with only a narrow cylinder of wood. It approaches very closely to the *Dendrosenecio* type.

On account of their short life the herbaceous species of *Senecio* referred to remain small. They possess, however, both an apical meristem and a vascular cambium, that is to say, the mechanism required for continuous increase in length and thickness of the stem, and such increase might be expected if the environmental conditions were appropriate and if the necessary genetical modification had been effected. If the activity of both these meristems were maintained by some suitable stimulus, and apical growth were confined to a single growing point, such herbs would resemble very closely in habit a dendroid *Senecio*, though it is obvious that the arborescent species themselves could only arise as a result of genetical changes.

Having obtained this evidence that the Dendrosenecios have a stem-structure more closely allied to herbs than to trees, a search was next made for a plant in which the early stages of the development of megaphytism might be studied. Various herbaceous genera were considered, and finally a member of our own flora was selected, namely *Brassica*. The species of this genus, in common with the Lobelias and Senecios, exhibit various types of herbaceous growth, but the wild cabbage of the sea-cliffs, *B. oleracea*, provided the type of stem which appeared most promising. Though the wild species is branched, many of the cultivated forms are unbranched, and bear a terminal rosette of leaves. This is strikingly so in the Tree Kale or Jersey Kale, *B. oleracea* var. *arborea*, which is grown as a field crop in the west of France and elsewhere. The plants live three years or longer and the stems reach a height of 6 or 8 ft. and become semi-woody, so much so that in Jersey they are used for the making of walking-sticks. Somewhat similar forms are cultivated in the tropics.

The origin of these *arborea* forms, which have been in existence for over a century, is not known. They have almost certainly arisen under cultivation, and selection has doubtless played a part in their production. We may assume further that a genetical change has taken place *. But however var. *arborea* may have originated, it affords an illustration of an herbaceous plant which by retaining its apical meristem and active cambium continues to grow and reaches an exceptional height. It appears, therefore, to show in essence the phenomenon of megaphytism. Its stem still retains some essentially herbaceous characters, namely, a limited amount of wood and a large central pith, whilst in build it may be said to approach that of an arborescent herb. Morphologically and

* The principle of reducing the number of shoots in order to impart exceptional vigour to the one or more which remain is much taken advantage of in horticulture, i.e. in the practice of disbudding, cutting back to a 'single eye', or the growing of sweet peas on a single stem. But the increased vigour which results here is clearly of a temporary nature only and not accompanied by any genetical change.

anatomically we have a type of growth similar to that found in the tall single-stemmed Lobelias.

Having seen that the genus *Senecio* possesses the mechanism for prolonged growth and that in *Brassica oleracea* a polyblastic species may become monoblastic, we may turn to a consideration of the plants growing on the mountain-side. We are confronted at once with a major and so far quite unsolved problem, namely, that as far as we know no other herbaceous plants on Kilimanjaro exhibit any startling variation from their normal habit. They do not show any special reactions to the peculiar climatic conditions obtaining on the mountain, and there is no trace of megaphytism. (The richly branched habit of trees and shrubs is obviously unsuited to react in a monoblastic direction and it is only to be expected that the few woody plants, such as species of Leguminosae and Ericaceae, which extend into the alpine zone, would show no unusual type of growth-form.) The most probable theory to account for this situation is to assume that the mutations or series of mutations which have taken place in other genera have not led in the appropriate morphological or physiological directions. That mutations have occurred on an extensive scale and in many genera is most probable, especially as it is known that polyploidy is particularly frequent at high altitudes.

Dr. Hare has reminded me of Went's work on auxin-development in stem-apices and its effect on the plant, notably in inhibiting lateral bud-development. In the massive growing plants of the Lobelias and Dendrosenecios a large amount of auxin would be elaborated. This would no doubt assist in the suppression of lateral shoots. If we suppose that mutations led to a progressive increase in size of the growing points it may be that auxin has also played a part in the gradual reduction from a polyblastic to a monoblastic habit. Augmented production of auxin, in conjunction with the peculiar environmental conditions referred to in the next paragraph, would reinforce the effect of genetical changes in bringing about the alteration in habit.

We may now view the problem from the ecological standpoint. We have seen that even in the cool temperate zone a moderate degree of megaphytism is found in the genus *Brassica* and that it occurs on a more extensive and impressive scale in the Echiums in the warm temperate regions. The ecological conditions of the high mountains under which the Dendrosenecios flourish have been analysed in detail and discussed in an earlier part of the main paper, but it may be emphasized here that since there is no fundamental difference between the edaphic conditions of temperate and tropical regions, the explanation of the more exuberant and remarkable growth in the tropics must be sought in difference in climate. The main factor governing this is, of course, solar radiation, and since the effects of other environmental factors are probably of minor importance, we must assume that it is the influence of this factor, felt in so many ways, which is fundamentally responsible for the vigorous and protracted growth of these herbaceous genera. This powerful stimulus is felt at low levels, but it operates with a very much greater intensity at high altitudes. The equatorial summits differ from other

mountains in one important particular, namely, that there is little annual variation in the intensity of heat and light, the climatic conditions being almost uniform throughout the year. There may be spells of rain and cloud, but there are no summer and winter seasons, and there is no resting period. As one would expect, annual rings in the *Senecio* wood are absent. New leaves continually expand, while cambial activity, relatively feeble compared to that found in a tree, is maintained month after month and year after year. Vegetative growth would, in fact, appear to be uninterrupted until the plants eventually give rise to large and, for a herbaceous plant, long overdue inflorescences. In the monocarpic Lobelias and in the two dwarf Senecios referred to the individual plant then dies, but in the tree-like forms, on account of the development of secondary axes, growth is continued for very many years, and it persists until the plants begin to fail through old age. On mountains remote from the Equator the effect of intense insolation in stimulating growth is likewise felt, but, as favourable growing conditions do not persist throughout the year, megaphytism is seen in a minor degree.

If we turn to the particular species of *Senecio* which occur on the five mountain groups and consider their origin, special problems are at once encountered. The typical tall species on each mountain might have been derived either directly or indirectly from forms similar to the two dwarf species; but this solution, which appears so simple and attractive, only partly solves the problem, and opens up fresh difficulties. Until these species and their local distribution are better understood it appears inadvisable to go beyond the general considerations outlined above.

Summary.

In these remarks I have tried to give a general picture of the main characteristics of these megaphytic Dicotyledons, describing briefly their morphology and anatomy, and the peculiar climatic conditions under which they grow. It is clear they do not form an entirely homogeneous group, yet the typical megaphyte is not difficult to recognize. It has certain structural characters, which may be summarized as follows:— (1) The possession of a single, or at most a few, large and very active apical meristems which give rise to a bulky, or to a tall, primary axis with complete or partial suppression of lateral axes; and (2) a cambium which possesses continuous but only moderate activity and gives rise to a relatively small amount of wood, whereas the cortex and pith are very well developed. In its highest expression we find this peculiar habit developed under the climatic conditions obtaining at high altitudes in tropical regions, the most important factor being, without question, the intensity of light and heat derived from solar radiation which in equatorial mountains is maintained at a uniform or nearly uniform level throughout the year. We are faced, however, with the difficult problem of accounting for the origin of this unusual type of growth and for its restriction to a very few genera. As in so many other similar instances, we are driven to the conclusion that mutations, coupled with natural selection, must have played an important part. It seems, indeed, not unlikely that the genetical changes initiated certain structural trends,

of which the most important would appear to be the gradual dominance of the apical meristem. The consequent increased production of auxin at the large growing point may then have played a supplementary rôle in inhibiting the development of lateral buds, so that the modification induced by mutational changes may in this way have been reinforced and even accentuated. At the same time, the remarkable climatic conditions of the tropical mountains, by providing an environment unusually favourable to active growth in the species concerned, may have still further promoted and emphasized these modifications.

The present communication does not profess to provide a complete solution to any of the many problems which are presented by the megaphytic habit. All that has been attempted is to focus attention on some of them and to offer suggestions which may point the way along which further progress may be made.

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